



U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**

DOT HS 807 257
Final Report

March 1988

Trauma System Development

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1. Report No. DOT HS 807 257	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle TRAUMA SYSTEM DEVELOPMENT		5. Report Date January 1988	
		6. Performing Organization Code	
7. Author(s) Peter Wolff, Lynn Barth		8. Performing Organization Report No. 88-1	
9. Performing Organization Name and Address Abt Associates Inc. 55 Wheeler Street Cambridge, MA 02138		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. DTNH22-86-C-05124	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Office of Enforcement and Emergency Services Emergency Medical Services Division		13. Type of Report and Period Covered Final Report October 1986-December 1987	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract <p>Trauma patients benefit from trauma systems that include prehospital services, communications systems, dispatch systems, vertically integrated trauma hospitals of varying levels, quality assurance procedures and rehabilitation services. The objective of this research was to see if there are any true trauma systems, how the manner in which trauma centers are designated affects them, what the financial impacts of trauma systems are on prehospital services and on hospitals. -- The methodology involved a literature review, an examination of previously collected data on trauma centers, a statistical analysis of American Hospital Association data, and site visits to five locations including one that is sparsely populated and does not have sufficient trauma cases to warrant a trauma center. They were Dade County, FL; Allentown, PA; Sacramento, CA; Amarillo, TX; and Bend, OR. -- Findings were that we did not see a true regionalized system of trauma care in any of the sites. We found that the manner of trauma center designation affects a trauma system: the stronger the designation, the better the system is likely to be. A trauma system increases costs of prehospital care; it also puts burdens on hospitals, particularly Level II trauma centers that cannot use residents to provide 24-hour coverage as demanded by the standards of the American College of Surgeons. -- Three major institutional factors promote development of a trauma system: legislative action, leadership by the regional EMS agency (including participation by the local community in decision-making, cooperation of the physician community, cooperation of the hospitals), and solution to the problem of unfunded trauma care. We recommend that NHTSA work with and strengthen each of these institutional factors.</p>			
17. Key Words trauma center, trauma system, trauma registry, EMS, communication system, dispatch, quality assurance, medical control, unfunded trauma care		18. Distribution Statement Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161	
19. Security Classif. (of this report) unclassified	20. Security Classif. (of this page) unclassified	21. No. of Pages	22. Price

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PREFACE

This report owes much to many persons. The authors wish to thank especially Dr. David Kidder, of Abt Associates' Health Economic Research Group, for his assistance and his preparation of the statistical analysis of how trauma center designation affects hospitals (included as Attachment III). We also wish to thank Taylor McNeil, who produced most of the literature review for in this report.

Thanks also go to the five sites and their personnel, who cooperated with us and made themselves available for this study. Limitations of space prevent us from mentioning everybody to whom we talked. The following five persons took the lead in getting us the information we needed: in Dade County, Sandy Sears; in Sacramento, Larry Karstead; in Allentown, A.J. Heightman; in Amarillo, Leland Lewis; and in Portland, Oregon, Channah Commanday.

Others who helped us were Gail Cooper, Chief of the Emergency Medical Services Division in San Diego County, and Sister Kathryn Hellman, President of St. Charles Medical Center in Bend, Oregon. We owe gratitude to our own consultants, Dr. Charles McCabe of the Massachusetts General Hospital, and Dr. Alisdair Conn, of University Hospital and of Boston MedFlight.

1.0 EXECUTIVE SUMMARY

In the Preface to Injury in America: A Continuing Health Problem, Dr. William H. Foegel¹ writes:

Injury is the principal public health problem in America today; it affects primarily the young and will touch one of every three Americans this year. But injury is a problem that can be diminished considerably if adequate attention and support are directed to it. Exciting opportunities to understand and prevent injuries and to reduce their effects are at hand. The alternative is the continued loss of health and life to predictable, preventable, and modifiable injuries.²

One of the proven ways of diminishing the problem of injury is the establishment and operation of trauma systems throughout the United States.

Trauma Care System means a system of health care delivery which integrates and coordinates prehospital EMS resources and hospital resources to optimize the care, and, therefore, the outcome of traumatically injured patients. It is comprised of communications, transport, and personnel prehospital resources coupled with standing transport protocols and/or medical control which insures the delivery of patients to the correct level of hospital care as defined by the vertical categorization and designation processes. It also includes medical review and systems evaluation to optimize prehospital delivery and patient care.³

The research whose results are presented in the following pages used a variety of methods, including literature review, case studies, and statistical analysis to gauge the current state of trauma systems development, especially in five selected sites. It must be remembered that trauma centers, and especially trauma systems are still new concepts in this country. The first trauma centers were designated in the late 1970s (see Attachment III); most of them were designated after 1981, and in many states there are as yet no trauma centers at all. The concept of a trauma system, as described above, is even newer and just beginning to be implemented in a few places.

In our research, we first examined whether there were any complete trauma systems; we then studied how the various parts of a trauma system work together in order to operate most effectively. Furthermore, we set out to discover the optimum method for development of trauma systems in those areas of the country where they do not yet exist. Finally, we searched for ways in which an agency, such as the National

Highway Traffic Safety Administration, could promote the development of trauma systems.

In our examination of trauma systems, we proceeded along two dimensions: first, we looked at the resources that are needed for a trauma system, namely, the hospitals, transportation facilities, communications facilities and the like, as well as the human resources required--physicians, surgeons, EMTs, paramedics, dispatchers, nurses, etc. Clearly, a trauma "system" that does not have adequate resources cannot provide optimum trauma care.

Second, we looked at how the various resources function together--do the EMTs follow established protocols, are surgeons available when needed, do the hospitals cooperate in sending patients to the right facility? A trauma "system" that has excellent resources but in which the resources are not properly working together, also will not be able to provide optimum trauma care.

In looking at our findings concerning trauma systems, it is also important to note that many of the problems relating to trauma system development should be seen in the light of current trends in health care policies. Trauma care is but one of many health care services that is affected by these policies that present both threats and opportunities:

- Uncompensated care. This is not just a problem of trauma care, but of all medical care. How to deal with it is a major problem affecting all health care and one that agencies like the Health Care Financing Administration (HCFA) are trying to cope with. Trauma care, however, seems especially affected by the unresolved nature of this problem.
- Cross-subsidization. This is intimately related to the previous policy. Until recently, hospitals could include in their charges to third party payors and to paying patients some of the costs of their free care services. New methods of payment to hospitals, however, emphasize cost containment and discourage cross-subsidization. Other ways of financing bad debt must be found, therefore.
- Health care competition. Hospitals are competing in ways that they are not accustomed to. Hospital administrators used to be able to work together to solve local health care problems. The current economic conditions in the hospital industry make cooperation financially risky. Hospitals realize that they are as vulnerable to financial pressures as other businesses.

- Selective contracting by payors. Whereas formerly many payors (Blue Cross, commercial insurance companies, Medicare) paid "reasonable and customary" charges to any provider, these same payors are now selecting only a few hospitals and physicians to provide certain expensive services to the insurer's subscribers. This demonstrates a new acceptance of the concept of "regionalization" of health care. This acceptance could presage a more positive attitude by state legislatures toward the "regionalization" concept critical to trauma center designation.

Our findings are presented in Chapter 6. The major findings may be summarized as follows:

- We did not find a complete regionalized system of trauma care in any of the five sites that we visited. We did, however, find partial systems that often delivered excellent trauma care. We found systems that are just beginning to be developed and that are still in the process of trying to add additional resources as well as working out the proper functioning of all resources.
- Trauma systems tend to differ according to local conditions. They are different in large urban areas, smaller urban areas, and rural areas.
- We found several different methods of designation and implementation of trauma centers and trauma systems. We also found that significant differences in the strength and viability of trauma systems could be attributed to the different methods of designation.
 - In California, we found county designation of trauma centers (through authority delegated by the state) and strong legislation. On the one hand, this makes for strong trauma centers and trauma systems. On the other hand, this strong designation also places obligations on trauma centers and tends to make some hospitals reluctant to apply for trauma center status.
 - In Florida, we found weak state legislation that resulted in any hospital being verified as a trauma center merely on the basis of its application and its certification that it met ACS standards. This in turn led to an excess of trauma centers when hospitals first applied (in Dade County), and then to the withdrawal of hospitals when they realized that being a trauma center had some negative financial implications.

- In Pennsylvania, we found strong legislation. The power to accredit trauma centers has been delegated to the Pennsylvania Trauma Systems Foundation. However, the legislation addresses only trauma hospitals and does not speak strongly about EMS or the other parts of a trauma system. Furthermore, hospitals are troubled by the fact that case load requirements are written into the standards which the Foundation must follow in designating trauma centers, yet these standards become effective only after the fact. Thus, hospitals are reluctant to make the resource investment to become trauma centers, when they may lose that designation if their second year case load turns out to be insufficient to meet the standards.
- In Texas, we found a state that lacked legislation concerning designation of trauma centers. The result, at least in the site which we visited, is that trauma care is dependent on the good will of the local physicians as well as the persuasive power of the head of the local EMS agency.
- In Oregon, we found state legislation and regulations that tried to differentiate between urban areas (like Portland) and rural areas (like Bend). The legislation is designed to make possible trauma care in sparsely populated areas that, because of reasons of demography and geography cannot meet either the case load requirements of ACS or the transport time goals of urban areas.
- We found the impact of trauma center designation on hospitals to vary from place to place. Myths of both financial salvation and financial disaster surround trauma center designation.
 - Trauma centers can be profitable. We found one case of this, in Allentown, Pennsylvania.
 - Trauma centers can contribute to the overall financial health of a hospital by increasing the occupancy rate. We found this to be the case in Amarillo, Texas.
 - Trauma centers are thought to enhance the reputation of a hospital in general and so increase patient flow. This was why six hospitals applied for Level II status in Dade County.

- Trauma centers generate a great deal of uncompensated care. This is why the six Level II centers in Dade County decertified themselves after a little over a year. It is also why there is difficulty in finding a second hospital in Sacramento County to apply for trauma center status.
- Studies in the literature are ambiguous about the financial impact of trauma centers. There are complaints that reimbursements (particularly Medicare reimbursements under DRGs) for trauma care are insufficient. There are also studies that show that motor vehicle crash patients (a large percentage of trauma patients) are a break-even proposition for hospitals. Other studies show that trauma centers do not get more non-trauma patients (even in the Emergency Department) than non-trauma centers.
- Our own study found ambiguous financial results. The percentage of bad debt for trauma varies tremendously across our five sites and the manner in which it is covered also varies.
- It is apparent that the problem of uncompensated care is a major disincentive to hospitals' participation in trauma care. If there is to be good, consistent trauma care, the problem of uncompensated care must be addressed and solved. Otherwise, development of trauma systems will lag. There is a health care policy issue here: whether and how uncompensated trauma care is paid for will determine the speed and vitality with which this service is developed.

In arriving at recommendations to NHTSA for promoting the development of trauma systems, we tried to look for "institutional factors." What changes need to be made in hospitals, in state departments of health, in the emergency medical system, in order to promote a well-functioning trauma system? The emphasis on institutional factors is meant to counteract the emphasis on "personal factors." Almost every well-functioning trauma system that we have visited or have heard of appears to be the "lengthened shadow"⁵ of one man. The lore of trauma system development is centered on individuals--who almost single-handedly through the strength of their personalities pushed forward the state of the art of trauma care.

There is no denying the importance of these kinds of persons. Good hospitals and excellent trauma centers always will need dedicated and able surgeons who place priority on saving the lives of the injured (and who place considerations of career and

money second). But we tried to go beyond this and identify factors such as organizational structures or certain funding mechanisms, which make trauma system development feasible. These kinds of factors are replicable; there is no extant prescription for how to find a strong and charismatic personality.

We identified three "institutional factors" that, if they work harmoniously together, promote the development and well-being of a trauma system:

- **Legislative action.** State legislatures must establish a designating authority for trauma centers, such as the Department of Health, or the County Board of Supervisors. Legislation must require plans to be drawn up for establishment and functioning of the parts of the trauma system--prehospital care, trauma centers, base hospitals, quality assurance, communications systems, etc. It must establish EMS regions, if necessary. It must provide for the legal status of trauma centers--their right and duty to treat all serious trauma. It must establish the liability of hospitals, physicians, and EMTs that do not honor a trauma center's role as the primary provider of trauma care. It must also provide funding for the trauma system and actively address the problem of uncompensated care.
- **Leadership by the regional EMS agency.** Among all the parts of the trauma system, it alone has a region-wide outlook so that it can see the trauma problems of the region. It has direct contact with the "consumers" of trauma care--the trauma patients--and it can see their needs. It is in a good position to mobilize the public's support for a trauma system, particularly funding support through tax monies. EMS and trauma systems are already linked in the public mind: Senate Bill 10 in the 100th Congress links funding for EMS and funding to improve trauma centers and defray some of their uncompensated costs. Such leadership will result in:
 - **Participation by the local community in the development process.** Under the leadership of the EMS agency, the public can demand that it receive good trauma care and express its willingness to politicians to support a trauma system through taxes. The public must be made to feel that a trauma system is their system--that they own it, and that they can benefit from it.
 - **Cooperation of the physician community.** In principle, all good physicians will support a well-functioning trauma system, but several fears must be overcome: fear of malpractice suits arising in the Emergency Department setting; fear of having a

large number of non-paying patients; fear of constantly being called out in the middle of the night if they participate in the system; fear of losing patients to a trauma team if they do not participate in the system.

- Cooperation of the hospital community. As above, in principle, all good hospitals will support a well-functioning trauma system. As in the case of physicians, some fears need to be overcome: there is again the fear of incurring vast costs for 24-hour staffing if they participate in the trauma system; the fear of losing patients (including non-trauma patients) to other hospitals if they do not participate in the trauma system.
- Solution to the problem of uncompensated care by federal and state agencies. Hospitals are faced with contradictory mandates that must be reconciled: the federal government now insists that hospitals can only be reimbursed for actual costs, thereby making "cross-subsidization" impossible. At the same time, state agencies demand that hospitals treat patients regardless of ability to pay, yet reimburse hospitals at less than cost for Medicaid patients. A solution must be found.

We found each of these factors working well in some of the sites we visited, but in none were all of the factors working well. The challenge to everyone interested in trauma care and trauma systems is to make them all work well and work together in each place where trauma care is needed.

NOTES

1. Dr. Foegel is Assistant Surgeon General and chairman of the Committee on Trauma Research, Commission of Life Sciences, National Research Council.
2. Injury in America: A Continuing Public Health Problem, Washington, D.C., 1985: National Academy Press, p. v.
3. National Highway Traffic Safety Administration, Contract No. DTNH22-86-C-05124, "Trauma System Development," Section C, Statement of Work, p. 4.
4. American College of Surgeons, Hospital and Prehospital Resources for Optimal Care of the Injured Patient and Appendices A through J, 1986.
5. Emerson, R.W., Essays, "Self-Reliance."

2.0 METHODOLOGY

The objective of this contract was to conduct a comprehensive study of existing trauma systems and the means for developing these systems. The following were to be analyzed:

1. The number of regionalized systems having true echelons of trauma care versus designation in name only.
2. The methods in which trauma systems were implemented, e.g., self-designation, regional designation, State designation, professional designation, etc., and the method or methods which appear to sustain true systems of trauma care.
3. The impact of trauma system development on prehospital EMS structures and costs.
4. The financial impact on primary care institutions, e.g., lost or gained revenues from patient flow patterns, insurance costs, equipment and personnel costs for designated centers, etc.
5. Recommended strategies for NHTSA and other administrations to follow in promoting comprehensive trauma system development, e.g., technical support teams, public information and education, model legislation, targets of opportunity, etc. (Statement of Work: Objectives p.6)

To address this objective and analyze the five items above, we used four different approaches:

1. We reviewed the literature on trauma, trauma centers and trauma systems.
2. We examined three sources of previously collected data that appeared to be especially promising, namely
 - a survey conducted by the EMS Clearinghouse for the National Association of State EMS Directors of all 50 states. The survey solicited information on trauma centers and trauma center designation
 - a survey conducted by NHTSA, through its regional offices, which also attempted to obtain information on current conditions of trauma centers
 - a study conducted by the U.S. General Accounting Office, titled Health Care: States Assume Leadership Role in Providing Emergency Medical Services. A chapter in that report is devoted to Cardiac and Trauma Care. Data for GAOs report were collected from six states.

3. An Abt study team visited five sites to collect data on trauma centers and trauma systems. In order to avoid duplication, three of the five sites were places that had also been studied by GAO.
4. We performed a statistical analysis of the effort of trauma center designation on hospitals, using nation-wide data collected by the American Hospital Association.

Details of these four approaches are provided in Attachment I to this volume.

3.0 THE LEGISLATIVE ENVIRONMENT OF THE TRAUMA SYSTEM

Like all medical services, the trauma system exists in an environment that is regulated and circumscribed by legislation. What doctors can and cannot do is subject to legislation as well as professional standard setting; what prehospital providers can do is similarly the subject of legislation. Furthermore, the training of EMTs and paramedics is regulated; the ambulances which transport trauma patients are regulated, as are the communication systems that dispatch ambulances and that provide the communication between prehospital providers and trauma physicians. Hospitals are subject to regulation by state and federal agencies; trauma centers, particularly, are subject in many states to legislation that mandates how trauma centers are designated or categorized and what standards trauma centers have to abide by in order to be designated or categorized.

In this chapter we review the legislation concerning trauma centers and the trauma system that exists in the five states where we made site visits. This will explain, when we describe in Chapter 4 what we found during the site visits, many of the special features of the components of the trauma system that we identified at the sites. Because legislative mandates concerning the trauma system have the force of law, they are probably more important than anything else in shaping a trauma system and determining whether it will be a strong and well-functioning or a weak and poorly-functioning system. Many other factors, as we shall see, influence the nature and character of a trauma system, but none so crucially as the enabling state legislation.

Perhaps the most important part of state trauma legislation is that which relates to trauma center categorization or trauma center designation. Hospitals that meet certain standards (usually standards derived from, or close to, the standards set by the American College of Surgeons, Committee on Trauma) may be categorized by the legislation as trauma centers; i.e., in terms of their staff and other resource capabilities, these hospitals are described as appropriate for the care of trauma patients. An additional step occurs if hospitals are not merely categorized but designated as trauma centers. Such designation, made by an appropriate authority defined in the legislation, implies that the hospital in question not only can provide appropriate trauma care, but that it is committed to do so and will provide trauma care. A further implication of designation is that a designated trauma center has, as it were, a monopoly on serious trauma cases in its region. Thus, another hospital which attempts to treat serious trauma patients does so at great risk of legal liability by providing inappropriate care when appropriate care (at the designated trauma center) exists in the region.

We now turn to the legislation in the five states we visited.

3.1 Florida

Florida does not designate trauma centers; instead, it verifies that a hospital meets standards for being a trauma center. (This is what we have called categorization above). Section 5, Section 395.032 Florida Statutes says that the Department of Health and Rehabilitative Services

- (3) ...shall adopt, by rule, standards for the verification of trauma centers based on national guidelines, including those established by the American College of Surgeons, entitled "Hospital and Prehospital Resources for Optimal Care of the Injured Patient," and published appendices thereto. The department shall also adopt by rule standards specific to pediatric trauma referral centers.
- (4) In those geographical areas where the department determines the need for trauma services, any hospital that desires to be verified as a trauma center must submit to the department a request for verification as such center. The request shall be reviewed by the department to determine whether the hospital is in substantial compliance with the standards specified in subsection (3)....

After verification of compliance with those standards, the department shall verify the hospital as a trauma center.

- (5) A verification, unless sooner suspended or revoked, automatically expires 2 years after the date of issuance and is renewable biennially upon application for renewal and payment of the fee prescribed in the rules of the department, if the hospital is in substantial compliance with trauma center verification standards in effect at the time of the application....
- (6) Any hospital which is verified as a trauma center shall accept all trauma victims that are appropriate for the facility regardless of race, sex, creed, or ability to pay.
- (7) It is unlawful for any hospital or other facility to hold itself out as a trauma center unless it has been so verified under this section by the department.

Section 6. Each emergency medical services provider licensed under chapter 401 shall transport trauma victims to hospitals verified as trauma centers, except as may be provided for either in department approved local or regional trauma transport protocol or, if no local or regional trauma transport protocol is in effect, as provided for in a department-approved provider's trauma transport protocol...

This legislation, though just passed in July 1987, is quite weak. It states that for any hospital whose compliance with the standards of the American College of Surgeons has been verified "the Department [of Health and Rehabilitative Services] shall verify [it] as a trauma center" (emphasis added). No site visit is required for such verification, so that this process is often referred to as a "paper verification," i.e., it is based on what a hospital says about itself in its application.

Since the legislation is quite recent, administrative rules and regulations have not been established yet. Draft rules are expected to be available in February 1988, with final rules required to be in place by August 1988.

3.2 California

In California there exists strong legislation concerning the establishment of trauma care systems. The state has an Emergency Medical Services Authority² in the Health and Welfare Agency. Each county, in turn, may establish a local EMS agency for administration of emergency medical services; such an agency may also be set up by several counties (for a regional EMS agency).³ The state authority is ordered by the legislature to establish minimum standards for regional trauma systems, which "shall include, but not be limited to," all of the following:

- (a)
 - (1) Prehospital care management guidelines for triage and transportation of trauma cases.
 - (2) Flow patterns of trauma cases and geographic boundaries regarding trauma and non-trauma cases.
 - (3) The number and type of trauma cases necessary to assure that trauma facilities will provide quality care to trauma cases referred to them.
 - (4) The resources and equipment needed by trauma facilities to treat trauma cases.
 - (5) The availability and qualifications of the health care personnel, including physicians and surgeons, treating trauma cases within a trauma facility.
 - (6) Data collection regarding system operation and patient outcome.
 - (7) Periodic performance evaluation of the trauma system and its components.
- (b) The authority may grant an exception to a portion of the regulations adopted pursuant to subdivision (a) upon substantiation of

need by a local EMS agency that, as defined in the regulations, compliance with that requirement would not be in the best interests of the persons served within the affected local EMS area.⁴

Local emergency medical services agencies may implement trauma care systems but only if they meet the minimum standards set up by the state agency.⁵ Finally, the legislation is very explicit about what a trauma facility is and what a trauma care system is:

- (a) "Trauma case" means any injured person who has been evaluated by prehospital personnel according to policies and procedures established by the local EMS agency pursuant to Section 1798.163 and has been found to require transportation to a trauma facility.
- (b) "Trauma facility" means a health facility, as defined by regulation, which is capable of treating one or more types of potentially seriously injured persons and which has been designated as part of the regional trauma care system by the local EMS agency. A facility may be a trauma facility for one or more services, as designated by the local EMS agency.
- (c) "Trauma care system" means an arrangement under which trauma cases are transported to, and treated by, the appropriate trauma facility.⁶

Unlike Florida's legislation, California's is very strong. Trauma centers are designated not just categorized. Either the state EMS Agency or local agencies can set up a trauma system, but only if they meet the standards of the legislation. And a trauma system means an arrangement under which trauma cases are transported to, and treated by, the appropriate trauma facility (see above). This implies legal sanctions if trauma cases are transported elsewhere or treated elsewhere, once a trauma system has been set up. Indeed, there have been cases in California where a trauma patient (or his estate) have sued hospitals and/or EMS providers, because the patient was not taken to the appropriate trauma facility.

3.3 Pennsylvania

In Pennsylvania, trauma centers are accredited by the Pennsylvania Trauma Systems Foundation. This foundation was set up by the state legislature under Act 45 of 1985. Earlier, the Department of Health itself had undertaken the designation process and, in fact, Lehigh Valley Hospital Center in Allentown (which we visited) had been designated in 1981 as the first trauma center in Pennsylvania. As a result of legal

action, further trauma center designation was delayed until the Pennsylvania Trauma Systems Foundation was set up and specifically empowered to accredit hospitals as Level I or Level II trauma centers, following the standards of the American College of Surgeons.⁷ The Act also required that the accreditation program be under way by June 30, 1985; otherwise the Secretary of Health was to set up a trauma center accreditation program.⁸ By the end of 1986, twelve hospitals in the Commonwealth had been accredited as Level I or Level II trauma centers (one was a pediatric trauma center in Philadelphia).⁹ Accreditation is not designation, but categorization or verification. It should also be noted that Pennsylvania's legislation addresses only hospitals, not other parts of a trauma system.

The American College of Surgeons' Hospital and Prehospital Resources for Optimal Care indicate that trauma surgeons and others associated with them in trauma care should treat at least 50 cases per year; otherwise skill decay is likely to set in. The ACS estimates that (based on the probable number of surgeons in an institution), Level I trauma centers should treat between 600 and 1,000 trauma patients per year; for Level II trauma centers, the estimate is 350 to 600 patients.¹⁰ The Pennsylvania legislation (Act 45) incorporates minimum case load requirements into the standards for accreditation which the Pennsylvania Trauma Systems Foundation is to apply--600 for a Level I, and 350 for a Level II trauma center. In the 1985 Standards for Trauma Center Accreditation published by the Foundation, this is Standard II. A hospital must have demonstrated capacity to care for trauma cases without disrupting other key hospital functions. When a hospital comes up for reaccreditation (after two years), this capacity must be demonstrated by showing that the minimum number of cases (600 or 350 per year) has in fact been treated.

There is concern in the Pennsylvania hospital community about the minimum case load standards, particularly the fact that they will be strictly enforced only at the time of reaccreditation. In order to be initially accredited, a hospital will have made a substantial financial investment in its trauma service and will continue to do so for two years without any idea of their likely trauma volume or the enforcement of volume criteria. Hospitals that have made such an investment and are receiving the benefits therefrom are likely to resist loss of accreditation because of caseload requirements. Thus there is a movement under way to have the caseload requirement removed from the statute. However, some persons think that dropping the caseload requirement will let the system revert to confusion and increase the risk of inadequate trauma care. The issue is unresolved, but is obviously important. The desire to drop (or reduce) the

caseload requirement is an example of the continual attempts to chip away at the strict requirements which must be met to be accredited as a trauma center. We shall see in California that the requirement for in-house presence of surgeons was an obstacle to hospitals applying for Level II status and that they attempted to have that standard reduced to surgeons being available on call at 20-30 minutes notice. These attempts to weaken standards are quite understandable and often have a realistic base in financial considerations; nevertheless, they seem to jeopardize the very intent of setting up trauma care systems: assuring the optimum care for trauma patients in the shortest possible time.

3.4 Texas

In Texas, there is no legislation mandating that trauma centers be designated and establishing the authority to do the designating. A bill to do so was introduced in the 1987 legislature but did not pass. It may be revived in the next (1989) session of the legislature. The Board of Health, therefore, ordered the Bureau of Emergency Management (BEM) to develop a plan for the vountary designation of trauma centers. As part of this plan, a study of two hospitals that now function as though they were designated trauma centers was initiated. The two hospitals to be studied are Parkland Hospital in Dallas and Northwest Texas Hospital in Amarillo, but the study was postponed to 1988.

There is legislation setting up a Bureau of Emergency Management and mandating that a state plan "for the prompt and efficient delivery of adequate emergency medical services" be developed. The state is divided into emergency medical service delivery areas (the Panhandle is one such area). A communications network is to be set up, so that departments of public safety, police departments, fire departments etc. can all promptly respond to medical emergencies and coordinate their efforts. The plans for the regions may include use of helicopters (but they are not mandated). Training of emergency medical service providers is to be encouraged and the Bureau of Emergency Management is to provide training if it is not available locally.¹¹

A little later, the act states that "this act does not require any system, service, or agency to provide advanced life support."¹² Finally the following is worth quoting:

A hospital that owns, operates, or serves as an emergency medical services provider and that is transporting a person who is unconscious or unable to communicate because of an injury, accident, or illness and who is suffering from what reasonably appears to be a life-

threatening injury or illness shall transport that person to the hospital that can provide appropriate emergency care nearest to the location at which the person was picked up.¹³

Although transport is mandated to be made to the nearest hospital that can provide appropriate care, this will not, in Texas, be a designated trauma center, since no mechanism for designation exists.

3.5 Oregon

Oregon does not yet have a formal, state-recognized trauma system but is in the process of setting one up. In 1983 the Health Department was asked by the Legislature to study trauma care under Resolution 23. The Resolution established the first State Trauma Advisory Board (STAB), mandating that a report be submitted to the next legislative session in 1985. (The Oregon Legislature meets every two years.) In its report, published July 1984, the STAB recommended that "each population area in the state should develop and implement a trauma system plan that is tailored to meet local needs and which effectively utilized local resources."¹⁴

In 1985, the Legislature passed Bill 147 which mandated the establishment of a statewide trauma system based on geographic "trauma areas" and the establishment of both State and Area level Trauma Advisory Boards, the membership of which was identified in the statute. The role of the Area Trauma Advisory Board is as stated in the original report by the STAB to the legislature: i.e., to develop trauma system plans for each trauma area. The legislation lays out the basic requirements to be included in each area plan:

- (a) Central medical control for all field care and transportation consistent with geographic and current communications capability.
- (b) The development of triage protocols.
- (c) One or more hospitals categorized according to standards adopted by the Health Division as rules and regulations, to be modeled after the ACS Committee on Trauma standards. Areas can choose to designate a single hospital to be the center, or can categorize, accepting all hospitals which meet the standards.
- (d) The establishment of Area Trauma Advisory Boards.
- (e) The establishment of the State Trauma Advisory Board, which will meet at least quarterly.

- (f) A liability clause which states that no provider will be held liable for acting in accordance with approved trauma system plans.

The 1984 STAB report also identified levels of trauma care capacity: Regional Hospital (Level I), Area Hospital (Level II), Local Hospital (Level III), and a fourth category of Community Hospital (Level IV) not included in the ACS standards, specifically meant for rural systems of care. Level IV Criteria were to be defined by the STAB.¹⁵

In response to the statute, the Division of Health established the STAB and implemented a process to develop the ATABs. Memberships were proposed by the Health Department for the ATABs. The State EMS Coordinator drafted geographic boundaries for all ATABs which could then be discussed as a first item of business.

The relationship between the STAB and the ATABs has been a close one, according to the EMS coordinator. The role of ATABs is both to react to and to initiate planning with the STAB, to design their own local systems and to develop the statewide rules and regulations that will govern the system. Rules and regulations for the Oregon Trauma System were promulgated during 1987.

A major issue in Oregon (identified in the site visit) is the tension between the urban and rural perspectives. Respondents identified a number of special rural problems. (1) Response time standards for pre-hospital care have to be adjusted to reflect the realities of rural distances. The standard for urban response is eight minutes 90 percent of the time, in contrast to rural, where the standard is a 45-minute response time, and to frontier, where the standard is 4.5 hours. (2) Early on, the STAB tried to ensure that all multiple trauma cases would be transferred to Portland -- although bad weather often makes transport over the Cascades by helicopter impossible. Even in good weather, helicopter time from Bend to Portland is one hour, and surface ambulance time to Portland is four hours. The representatives from rural areas supported the treatment of trauma patients in Level II facilities located in the areas. (3) Caseload requirements for particular levels of care need to be adjusted to reflect the lower population density and utilization in rural areas. Initially the STAB required 350 cases for a Level II hospital (as per ASC standards). This was adjusted to 250 in the draft standards to reflect the rural conditions. Caseload requirements apply only to hospitals that are designated; in areas using categorization, caseload requirements are omitted.

Separate rules were adopted for Portland (which wanted to exceed the state standards). The rest of the state (including ATAB 7 where our site visit was made) uses a somewhat less strict set of standards. The rules and regulations expand on the legislative requirements by addressing standards for all components of the trauma system, including communications, response times, rehabilitation, quality assurance, education, prevention, and disaster management, in addition to the requirements in the statute.

NOTES

1. Section 395.032 Florida Statutes, Sections 5 and 6.
2. California Health and Safety Code, Division 2.5, Emergency Medical Services, Chapter 3, Section 1797.100.
3. Ibid., Chapter 4, Section 1797.200.
4. Ibid, Chapter 6, Article 2.5, Section 1798.161.
5. Ibid, Section 1798.162.
6. Ibid., Section 1798.160
7. Laws of Pennsylvania, Act 1985-45, Sect. 6 (a)
8. ibid., Sect. 6 (f)
9. See Appendix B, List of Trauma Centers
10. op. cit. (1986), p. 3
11. Emergency Medical Services Act, Article 44470, Vernon's Texas Civil Statutes, Article 2.
12. ibid., Article 3, Section 3.09
13. ibid., Section 3.19
14. Oregon Trauma System Plan, Special Report submitted to the Oregon State Health Division, by the State Trauma Advisory Board, July 1, 1984, p. 1.
15. ibid., pp. 10-12

4.0 EXISTING TRAUMA SYSTEM MODELS

In this chapter we describe what trauma systems look like -- what their parts are and how they function together. These descriptions are based on the five site visits which we undertook during 1987 (to Dade County, Florida; Sacramento, California; Allentown, Pennsylvania; Amarillo, Texas; and Bend, Oregon).

We explain, in Attachment I, how these five sites were chosen and what our site visit/case study approach was. In this chapter, we detail for each site what we learned about the following parts of the trauma system:

- prehospital care (emergency medical services) including, where applicable, medical helicopter service.
- communication systems, not only for medical control, but also for dispatch of ambulances (including air ambulances), as well as for the public to access the system.
- medical control for both hospital and prehospital care (ideally provided by radio communication between a physician at the Level I trauma center and EMTs and physicians at other hospitals) including triage criteria.
- acute care hospitals, working cooperatively, that have been designated or categorized as trauma centers.
- quality control procedures, and a trauma registry, if one exists.

A complete trauma system also includes rehabilitation facilities to restore trauma patients to the best possible physical condition after their acute needs have been attended to. However, examination of rehabilitation facilities was beyond the scope of this contract.

Below we indicate the findings for each of these parts that emerged from our site visits, paying particular attention to how these parts should function together. We summarize our findings concerning components in a table at the end of each subsection.

4.1 Prehospital Care: Emergency Medical Services

In its 1986 report Health Care: States Assume Leadership Role in Providing Emergency Medical Services, the General Accounting Office defines emergency medical services as:

"...the resources used to deliver medical care to those with an unpredicted immediate need outside a hospital and continued care once in an emergency facility."

(op. cit., p. 10)

The report continues:

Studies have shown, and EMS experts generally agree, that the efficient and systematic delivery of EMS saves lives and reduces disability...

The critically ill and injured benefit the most from timely delivery of appropriate care. If their lives are to be saved, individuals with serious injuries or acute cardiac problems must receive appropriate medical treatment as quickly as possible. How quickly? The simple answer is that every minute counts—their lives are measured in minutes—and the faster treatment is rendered, the better. Dr. R. Adams Cowley, one of the foremost authorities in the field and director of the Maryland Institute for Emergency Medical Services Systems, has formulated what he terms the "golden hour," indicating that there exists a single precious hour in which to locate and treat a critically ill or injured victim.

To provide timely and appropriate emergency medical care, it is generally accepted that a local emergency medical services system must:

- permit fast and easy public access to emergency medical resources,
- quickly dispatch the most appropriate ambulance,
- provide timely and appropriate on-scene care, and
- swiftly transport victims to the most appropriate emergency care facility.

(ibid.)

In our site visits, we found excellent Emergency Medical Services in all five sites. That is not to say that there were not some problems, particularly with care in outlying rural areas, but overall the five EMS services provided excellent facilities and care. Many of them also had a leadership role in the existing or emerging trauma system in their area.

Dade County, Florida has, as we shall see, many problems with its trauma system. EMS, however, was not one of the problems. The county is served by five different EMS systems; one each for the cities of Miami, Miami Beach, Coral Gables and Hialeah and one for the remainder of the county. A single organization, known as MetroDade, provides police and fire protection for the county areas. There are no EMS regions; the county lines serve as EMS borders. Emergency Medical Services are provided by the five fire departments in the five jurisdictions mentioned.¹

There are also two private ambulance services operating under contract to the City of Miami and private air ambulances. These provide only BLS service, whereas the fire departments provide 100% ALS service. MetroDade also provides helicopter service when time is critical or when, because of rush hour traffic, the ground ambulance cannot respond in the desired time.²

The time goal for ambulances in MetroDade to respond is less than six minutes from the time the call is received to arrival at the scene of the emergency. In 64% of the cases in MetroDade this goal was met; where it was not, this was largely due to response times in rural areas (Dade County includes large portions of the Everglades). In the urban area of the City of Miami, a four-minute goal is generally met. The air transport guidelines state that the helicopter will be used when the transport time either to the scene or from the scene to the trauma center is more than 20 minutes. The helicopter is only used for patients who meet the triage criteria for rapid transport to a trauma center. (Triage is discussed in Section 4.3.)

Paramedics use established trauma triage criteria to determine if the patient should be transported to a trauma center rather than the nearest hospital. In November, 1986, an additional criterion was added, namely, that in cases where the paramedic suspects that the patient may have a significant injury, even if the other criteria are not obviously met, transport to a trauma center is appropriate. Thus paramedic judgment may be used to make the trauma-center-transport decision. Bypassing of local hospitals, therefore, does occur regularly whenever the triage criteria for transport to a trauma center are met.

Finally it should be noted that in Dade County there is a \$75.00 charge for emergency transport by MetroDade, soon to go up to \$120.00. As a public safety agency, however, neither MetroDade nor any of the city fire departments can refuse transport because of inability of the patient to pay.

Sacramento County is one of the seven counties in the Sierra-Sacramento Valley (S-SV) EMS Region in California. Sacramento County contains a sizeable urban area and about half of the population of the entire EMS region. The other six counties (Yolo, Sutter, Yuba, Sierra, Nevada and Placer) are rural and sparsely populated, though they experience temporary increases of population from tourists particularly on long holiday weekends. As might be expected, in an area so large and so diversified, Emergency Medical Services approaches are quite different throughout the region.

Although state legislation permits the development of trauma systems, only Sacramento County in this region has taken steps to do so. It consciously designed an interim system focused on only the most critically injured. A more extensive plan is expected to be adopted in the future. The EMS region would like to extend the trauma system development to include the rural areas. At present, the six rural counties have eleven hospitals, a 911 response system, many EMTs of various levels, about 80% ALS coverage and access to air ambulances. These parts are not, however, organized into a trauma system as yet.

In Sacramento County the University of California Medical Center at Davis is the designated trauma center for the county (Level II) and receives about 1,200 trauma patients per year. The Emergency Medical Services are provided by the fire departments which are first responders and by 7 private and 4 public ALS ambulance companies. The entire county is covered by ALS service. There are also two helicopters available, one provided by the University of California Medical Center (Life Flight) and the other by the California Highway Patrol (CHP). Life Flight will respond to calls from any first responder or from any public agency requesting their service; calls from the public are handled by referring the caller to 911. (This procedure appears both to prevent abuse of the helicopter service and to eliminate friction between the ground ambulance companies and Life Flight, since there is no direct competition.)

Ambulance response time in Sacramento has a goal of 10 minutes. This takes into account the fact that much of Sacramento County is rural, with long distances. The EMS agency reports that this goal is generally met. Statistics collected for one six-month period in 1985 show that response time varied from one to sixty minutes, with a mean response time of 6.6 minutes. However, more than 4% of the calls had a response time above 30 minutes. There was also concern that too much time was being spent at the scene of the emergency. The standard of ten minutes on the scene was met only 21% of the time; forty percent of the calls took 15 minutes or more.³

Emergency Medical Services in Allentown, Pennsylvania operate under a comprehensive EMS statute. It establishes staffing requirements for emergency medical services, building up staffing from advanced first aid training to paramedic capacity over a three-year period. A statewide support structure, the Pennsylvania Emergency Health Services Council, is the official advisor to the Department of Health regarding emergency medical care. The Council is composed of representatives from 70 organizations, including the EMS regional councils, municipalities, professional

organizations, etc. The PEHS Council has played an active role in the support for legislation and in the establishment of the Pennsylvania Trauma Foundation. The Department of Health funds the development of EMS capacity through State and Federal funds.

Emergency medical prehospital services are available throughout the six-county region, with Basic Life Support being more extensive than Advanced Life Support. Most EMS services are provided by BLS-trained volunteers. ALS services by paid paramedics are available mostly in urban areas (through the Fire or Health departments). The regional providers share a region-wide set of policies and procedures, articulated by a manual and compiled and distributed by the Regional EMS Council.

A simple vital sign and mechanism of injury classification model is used for identification of patients to be triaged to the trauma center. If transport to an advanced facility will take longer than 20 minutes, the patient is taken to the nearest hospital for stabilization.

Helicopter services are provided through MedEvac, based at Lehigh Valley Hospital Center (LVHC), and staffed with a flight nurse and a paramedic. The helicopter can be summoned by paramedics and fire chiefs, and the police at a scene as first responders can put it on alert. There is a mechanism for recall. Of the 750 annual calls, 60% or 450 are on-scene trauma flights and 18% are trauma related transfers. To address the concerns of non-trauma center hospitals, the records of all helicopter cases are reviewed quarterly by a sub-committee of the EMS council for over-triage. From this case review process, over-triage is determined to be about 7%. A similar process does not exist for prehospital ground transport, although every ALS case record is reviewed by the EMS Medical Director.

An important aspect of the trauma care system in eastern Pennsylvania is the EMS council's strong leadership role, both in the establishment of the system and maintenance and improvement. The EMS Council is supported through state appropriations and federal funding, and is a member of the Pennsylvania Emergency Health Services Council.

Three physicians who were active in the development of the trauma system continue to be active on the EMS Council, and in the development and implementation of training programs for EMTs and paramedics. One physician, the EMS Medical Director, oversees quality assurance for paramedics. It should be noted here that there is a

very strong relationship between the designated trauma center and the EMS agency. The LVHC demonstrates its commitment to the EMS agency through use of Pool Trust monies. Pool Trust monies, a fund left to the hospital by a local manufacturer for support of service development, are used for the improvement of the communications system for the region and support a prehospital program at LVHC that includes the operation of a Training Institute and a physician director.

Emergency medical services for the Texas Panhandle are coordinated by Panhandle Emergency Medical Services Systems, Inc. (PEMSS). PEMSS was initially set up in the '70s as an independent organization with its own board of directors. Its mission was to develop the pre-hospital system in the Panhandle through training, education, record keeping, provision of communication services and quality control. For some time, Northwest Texas Hospital (NETH) has been the main financial support of PEMSS. On October 1, 1987, NETH formally acquired PEMSS.

There are some 55 ambulance services in the Panhandle; all of them are volunteer services except for paid services in Amarillo, Pampa, Borger and Canyon. Despite this, more than 75% of the ambulance attendants are qualified for ALS and the goal is to have a 100% ALS system.

PEMSS operates a Communications Center located at Northwest Texas Hospital. It receives calls from the public throughout the Panhandle and dispatches ambulances according to the location of the emergency. If the situation warrants it, an ALS unit can also be dispatched to provide mutual aid to a BLS unit. Because of the large number of ALS-certified personnel, an ALS unit is never more than 15 minutes away from a BLS system.

Since there is only one emergency department, the Amarillo Emergency Receiving Center of Northwest Texas Hospital, there is never any question as to where a serious trauma patient ought to go. Over time, the small rural hospitals have come to recognize that they cannot handle serious trauma appropriately and cooperate in sending trauma patients to NETH. Because of the large size of the Panhandle catchment area, some transport times to NETH can be very long -- two hours or more. In some serious cases, therefore, the ambulance will stop at a nearby hospital to have the patient stabilized (perhaps to have blood administered), but only if advised to do so by Medical Control. A medical helicopter service obviously is desirable, but the region so far has not been able to afford one. This is one of the problems for a rural area: its large size make air transport very desirable, but its lack of resources makes it very

unlikely that such an area can afford a helicopter or plane. Eastern Oregon, as we shall see, has the same problem.

Medical Control is also located at Northwest Texas Hospital, in the Emergency Department. Supplementing Medical Control is a set of protocols (one for paramedics, EMT-SS, Pediatrics, and one for Basic EMTs). A revised set of protocols is going into effect September 1987. The following statement is from the preamble to the 1987 revision of the protocols:

As the scope of training and subsequent knowledge base and skill levels of the paramedic continue to grow, so too must the abilities and responsibilities given to those prehospital personnel. Faced with the challenges of long transport distances, complex medical or traumatic emergent situations and new philosophies regarding this management, the paramedic must provide a higher standard of care.

...more responsibility [has been given] to the paramedic. New ideas on treatment regimes, new additions to the pharmacologic inventory and the ability of the paramedic to perform invasive medical procedures, have given rise to a comprehensive and advanced set of prehospital paramedic protocols.

The revision of the 1986 protocols includes a progressive attitude toward decreasing morbidity and mortality in the Texas Panhandle.

There is a total of 50 protocols for paramedics, and 49 for EMTs, both covering what is to be done in specific medical situations.

The pre-hospital care system received high praise from everyone we talked to; it appears to function exceptionally well. The paramedics have no problem in deciding where to take a trauma patient. The high percentage of ALS-certified paramedics contributes to the excellent functioning of the system. The communications system appears to be very effective and is critical to the system's ability to function without a helicopter. The rural hospitals appear to be cooperating.

Overall, emergency medical services in the Texas Panhandle are a good example of what can be accomplished at the local level, under strong leadership from the EMS organization, without state and federal support. (State legislation concerning trauma centers is pending but not yet passed; federal funds helped to establish PEMSS, but have now dried up.)

The area in eastern Oregon that we visited includes the counties of Jefferson, Wheeler, Grant, Crook, Deschutes and portions of Harney, Lake and Klamath counties. The largest city in the area is Bend with a population of about 20,000. The population

of the entire area (organized as belonging to Area Trauma Advisory Board Seven) is approximately 121,000 , spread over approximately 19,000 square miles.

Trauma systems are just now in the process of being set up in Oregon. The establishment of Area Trauma Advisory Boards (ATABs) is part of that process. The service area of ATAB Seven is a good illustration of some of the problems faced by rural areas throughout the country. Although smaller than the Texas Panhandle, ATAB Seven's area has some additional problems. Unlike the flat Texas Panhandle, this area is mountainous and suffers from concomitant problems, such as severe winter weather, long driving times over mountain passes, and communication deadspots resulting from interference of mountains.

Each county has its own pre-hospital system; all employ public ambulances, and all but one are part of the Fire Department. Most of the EMTs in the Fire Departments are volunteers, and most are at the EMT-I Level. Some ALS is available in the larger towns, such as Bend, Prineville, Jefferson City, and Sun River. Funding for pre-hospital care comes from property taxes and fire service district taxes.

A helicopter service, Air Life, was begun in 1984. In 1983 the East Cascade EMS Council was concerned that death rates in its area were 2.56 times higher than in the urban areas. The Council determined that the problem was long transport times and decided to consider development of a helicopter service. Air Life is organized as a separate not-for-profit company, although its initial sponsor was St. Charles Medical Center. The intent is to operate as a community resource and therefore, it has sought affiliation relationships with a number of hospitals in a 150-mile radius (larger than ATAB Seven). Seventeen hospitals have become affiliates; as affiliates, the hospitals pay \$500 for every patient delivered. In its operation, Air Life will pick up patients and deliver them to whatever hospital Medical Control for the patient decides.

The relationship between the pre-hospital and hospital levels of care varies throughout the region; medical control is unevenly available. St. Charles Hospital has provided medical control for twelve years. At Redmond Hospital, the pre-hospital system is linked through an RN in the Emergency Room, who provides training for the EMTs, and medical control is also provided. In John Day, the ambulance is located at the hospital, and a hospital RN goes on all serious calls. In other counties, medical control appears to be unavailable. It also appears that there is no medical direction at the EMS council level. Quality assurance for the Bend Fire Department is conducted gratis by the Emergency Department director of St. Charles and other physicians. QA programs for other EMS services are not known at this time.

The system of care currently existing in Eastern Oregon is basically a structure of a majority of BLS pre-hospital care, with some ALS services available in the more populous towns, and a network of small hospitals and one larger medical center. The problems faced by the area in terms of pre-hospital care are the following:

1. The concept of the "golden hour" is almost impossible to implement in the rural areas of the region. The service area for John Day Hospital, for example, is almost 60 miles wide. Although helicopter service is available, many calls are still answered by ground transport (because of weather, location, unclear medical situation, etc.) and therefore arrival to the scene can take longer than an hour to begin with. Another factor is the problem of notification of a trauma case -- frequently an accident is not noticed until another person comes onto the scene. One method used to address this problem of time lags has been the training and equipping of volunteers who can go immediately to the scene of an accident close to their homes, rather than having to go to a central point to pick up a vehicle and equipment. Training farmers in the outlying areas to act as first responders is another method used.

2. The level of skills available for pre-hospital care is limited. Most BLS emergency medical care services are provided by volunteers, who have not received advanced training, because it is difficult to take time to do so as a volunteer. This is also a problem for the volunteers in the Texas Panhandle. Also, since trauma cases are few (because the population density is low), skill decay is a serious problem. Prior to the development of the area trauma plan, EMT courses were offered only in Portland, which is a one-hour flight or a four-hour drive away. Now the plan is to offer EMT courses through the local community college.

3. There are serious problems in communications. Because many outlying rural hospitals do not have 24-hour emergency rooms, many local pre-hospital systems do not have medical control. In addition, the character of the terrain is such that there are many blind spots in which the current radio transmission system doesn't operate. Communication is a problem as well for Air Flight, since the flight distance limits the radio transmission for medical control.

4. Funding is a problem at the pre-hospital level. Most of the towns in the area have sparse tax bases, and therefore cannot afford adequate ambulance and communications equipment. Air Flight is also not breaking even; this past fiscal year it operated with a loss of \$100,000. Its plans to recoup this involve the selling of subscriptions for emergency use to private families living in the very rural part of the area.

Table 4-1 summarizes the prehospital care in the five sites.

4.2 Communication System

There is a double need for efficient communications in the trauma system:

First, the public must be able to access the system--principally the Emergency Medical System--so that a trauma patient can quickly be transported to the trauma center if required, or to other definitive care if that is appropriate.

Second, within the trauma system itself, efficient communications are important. Paramedics or EMTs must be able to communicate with medical control to get advice on procedures and to help them make the judgment of whether to bypass the nearest hospital in order to take the patient to the trauma center. Medical control at the trauma center also must be able to be in touch with other hospitals, regarding transfer of a patient to the trauma center (or to settle any dispute between a local hospital and EMTs concerning the proper destination of a patient).

The GAO report comments as follows:

The expeditious response of emergency medical services begins with an effective system of public access and efficient ambulance dispatch. Studies show that this can best be provided by a single coordinated system that accesses all ambulance service providers in the area through the commonly known 911 emergency telephone number. Nonetheless, many areas find this difficult to accomplish, due to fragmentation among both service providers and local governments within an area, as well as the high initial cost of installing central telephone reception and dispatch equipment. State mandates requiring 911 coverage, coupled with state provision of a local funding mechanism, have helped some areas overcome these barriers, but only six states nationwide have taken both these actions.

(op. cit., p. 30)

Dade County is fortunate in that the 911 access number is available throughout the county. Since there are five different jurisdictions that handle emergencies whether these be medical, fire, or police-related, the 911 system is designed automatically to route a call to the appropriate dispatch center. The system recognizes the number from which the call to 911 is made and routes it accordingly. It also displays the calling number for the dispatcher. An even better system would, of course, display the geographical location of the calling number on a computer-generated map, so that the dispatcher, with the help of the computer, could locate the nearest available piece of emergency equipment to dispatch. While we have seen some

Table 4-1

Prehospital Care in the Five Sites Visited

	Dade County, FL	Sacramento, CA	Allentown, PA	Amarillo, TX	Bend, OR
Providers	5 fire departments; some private ambulance companies	fire departments; 7 private, 4 public ambulance companies	mostly volunteers; paid EMTs in urban areas	55 volunteer companies; paid in 4 cities	Public ambulances run by fire departments, staffed by volunteers.
Level of Service	100% ALS by fire departments; private companies BLS	100% ALS	BLS by volunteers; paid paramedics for ALS	75% ALS; goal is 100%	mostly BLS in rural areas; some ALS in cities
Helicopter Service	Available through MetroDade throughout	Available through UCD, if called by first responder or public agency	Available through LVHC, all cases must be reviewed	Not available	Private, non-profit service
Leadership of EMS Agency	Weak, submerged in fire department	Weak, though legislation permits strong role	Strong leadership role	Strong leadership role	Currently weak; plans call for strong advisory board role

such "enhanced" 911 system--and they are obviously within the state of the art--Dade County does not have such a system, largely for reasons of cost.

As for communication between personnel on ambulances and medical control, it also appears to be well in place in Dade County. Paramedics from MetroDade and from the City of Miami are in touch with medical control (either at Jackson Memorial Hospital or at Baptist Hospital for the County--at least at the time of writing) when they transport a patient. If there is any disagreement about where to transport the patient, the dispute is settled between medical control (a physician) and the physician at the other hospital. Thus paramedics or EMTs do not get involved in a conflict with physicians (in which it would be very difficult for a non-physician to prevail, regardless of the merits of the case). Telemetry is available but is not being used much.

In Sacramento County (as in all of the Sierra-Sacramento Valley Region and indeed all of California), 911 is available throughout. Sacramento has enhanced 911, giving the dispatcher information as to where the call is coming from.

911 calls go to Sacramento City Police, to three fire departments in the county or to the Sacramento County Communications Center (CCTR). All ambulances are dispatched by the CCTR, i.e., the police or fire departments route a medical emergency call to the CCTR.

Medical control in Sacramento County for trauma cases is exercised by five base hospitals and UCD/MC. There are some communications problems due to aging systems and overcrowded channels. Since state law requires that ambulances take patients to the nearest appropriate hospital (emphasis added), there is no problem of bypassing the nearest hospital. In fact, the opposite is the case. There is probably considerable overtriage in the county, with perhaps 30-40% more trauma patients coming to UCD/MC than necessary.

Pennsylvania does not have state legislation that mandates availability of "911" (as California does). In Allentown, 911 is available, but this is not the case in all of the six counties covered by the Eastern Pennsylvania Emergency Medical Services Council. Each county has a central dispatch system, and the dispatcher calls either a BLS or ALS ambulance and puts the medical helicopter on standby if the situation seems to warrant it. The helicopter is not directly dispatched by the central dispatcher, largely because of the concerns of area hospitals that Lehigh Valley Hospital, the designated trauma center, might "steal" some of their cases through use of the helicopter. The helicopter is fully funded by Lehigh Valley Hospital Center; this

explains the fear of other hospitals. The EMS Council placed 28 conditions on the helicopter program before it would support it and insisted that all helicopter cases be reviewed quarterly by a committee of physicians from the surrounding hospitals. The actual decision to call the helicopter is made by personnel at the scene of the emergency--police, EMTs or paramedics. Medical control can, however, cancel such a call if in its judgment air transport is not needed.

To reach medical control (or "medical command" as it is called in this region), paramedics use a UHF channel. There are seven UHF towers in the region; they are linked to different hospitals in the region, since six different hospitals (including LHVC) participate in medical command. If telecommunications cannot be established between EMTs-paramedics and medical command, the EMTs-paramedics have written protocols to fall back on.

In the Texas Panhandle, there is a single access number for the public to call Emergency Medical Services. It is not the 911 number; rather it is a toll-free 800 number (1-800-692-1331). All calls go to the Communications Center located at Northwest Texas Hospital. The major disadvantage of the "800" number is that it must be separately remembered or written down and that it poses a difficulty for tourists and others passing through who are faced with an emergency. Since I-40, a major east-west interstate highway, goes right through the Panhandle and Amarillo, there is a good possibility of "strangers" having to reach emergency care. Emergency calls to "O" (Operator) are patched through to the Communications Center by the operators receiving the calls; the volume of these calls is quite insignificant.

The Texas legislature, though it did not mandate that regions install "911," promised to fund establishment of "911" for any region that wanted it. The Texas Panhandle expects soon to have a region-wide "911" system, which would be one of the largest 911 in the U.S. Operation of the system will be funded by a \$1.00 per telephone per month surcharge.

The Communications Center is staffed 24 hours a day, seven days a week; this requires a total of 9 communications technicians (2 per shift). Obtaining the necessary information from the caller, assessing the situation and dispatching a unit generally takes only one minute. The Communications Center is able to reach all of the Panhandle area thanks to a system of repeaters that was purchased about 15 years ago with federal funds. There are only a few "dead spots" in the entire Panhandle area.

A UHF system is used for communication between EMTs/paramedics and medical control which is located at the Amarillo Emergency Receiving Center (at Northwest Texas Hospital). The emergency physicians at the AERC provide the medical control and give instructions to the EMTs/paramedics if necessary. (There are also two sets of protocols--one for EMTs and one for paramedics--that are used when communication with medical control is not possible.) Directions concerning which hospital to take a trauma patient to are not necessary, since AERC (by agreement with the other two major hospitals in Amarillo) currently receives all trauma patients.

The rural area of eastern Oregon has, as might be expected, serious communication problems. These arise in part from the fact that the area is large, mountainous and sparsely populated; but in part they also derive from the fact that no trauma system is as yet in place. Each area is required by the state to develop plans which are to describe "how each of the following standards are met or exceeded."

The plan then lists the following standards for "Communications and Dispatch":

- (a) System Access: Residents and visitors in a catchment area will access medical help by calling a single number.
- (b) Dispatch Response: Dispatchers of emergency medical resources will have protocols which include pre-arrival patient care instructions and which require the dispatch of the appropriate level of available responding units (Advanced Life Support or Basic Life Support) based on medical need.
- (c) Special Resources: All emergency services dispatchers will have a list of routinely available police, fire responders, air and ground ambulances, quick response team and special responders for extrication, water rescue, hazardous material incidents; and protocols for their use.
- (d) Pre-hospital/Hospital: Transporting vehicles will have either a UHF or VHF radio that will allow communications with the base hospital or their dispatch agency. If the information has to be relayed through the dispatching agency, that agency will be responsible to relay patient information to the hospital.
- (e) Interhospital: Interhospital data transfer, e.g., landline, radio, microwave, will be possible throughout the trauma system area.
- (f) Training: There will be procedures for providing medical dispatch training to emergency dispatchers.

(Proposed Rules, Oregon State Health
Division, Emergency Medical Services,
February 9, 1987, pp. 12-13)

The current situation in ATAB 7's region is far from these ambitious goals. The city of Bend has "911" but most rural counties do not. According to our informant in Bend, only about 30% of the region can be reached by their communication system because of hills and because of simple lack of equipment. The medical helicopter, Air Life, is often out of range of transmitters and therefore is out of physician control. A system is being developed to provide radio communication for the smaller towns, so that the EMTs who do not now have medical control can have it.

All in all, the conditions under which the health care system must operate make this a fairly dismal picture. First it is hard to reach the dispatcher, and then it is hard for the EMTs (once they have been dispatched) to stay in touch with medical control. Chances of providing good prehospital care during the crucial first hour after an accident are much diminished, therefore. There is no lack of understanding of what is needed: the proposed state rules address these problems, but the implementation of these rules is going to be very difficult and expensive. This is a problem arising from the rural character of the area. We would expect that similar problems exist in large areas of Nevada, eastern Washington, Idaho, Montana, Wyoming, Utah, Colorado, North Dakota and South Dakota, Arizona and New Mexico. Even a state as rich and populous as California may have similar problems in its mountainous eastern portions (i.e., on the eastern escarpment of the Sierra Nevada). Flat territory doesn't solve all of these problems, but does make them more manageable, as we saw in the Texas Panhandle. Mountainous terrain adds to the difficulties of providing adequate prehospital trauma care faced by all rural areas.

Table 4-2 summarizes the communication systems of the five sites.

4.3 Triage and Medical Control

One of the continuing questions in providing care for trauma patients is whether it is best to rush a patient as quickly as possible to a nearby hospital ("scoop and run") or whether it is better to provide some basic medical care at the scene of the emergency and during the transport to the hospital. If the decision is to take the patient to a hospital, the additional question arises whether this ought to be a trauma center or not. These kinds of decisions are part of what is called triage, "the medical screening of patients to determine their priority for treatment," especially large numbers of casualties in a disaster by dividing them "into three groups: those who cannot be expected to survive even with treatment; those who will recover without treatment; and the priority group of those who need treatment in order to survive."⁴ In

Table 4-2

Communication Systems in the Five Sites Visited

	Dade County, FL	Sacramento, CA	Allentown, PA	Amarillo, TX	Bend, OR
911 availability	throughout	throughout	in city, but not everywhere in six counties	not available, but an 800 number is. 911 expected August 1988 with 5 primary answering points	Bend has 911, rural areas do not. Single access number mandated by legislature for future
Routing of call received	automatically to one of five dispatching centers depending on origin of call	to 5 primary answering points, then to County Communications Center	each county has own dispatch system	all calls go to ComCenter; all ambulances dispatched from there	
Radio communication with medical control	in place to Jackson Memorial Hospital	in place to base hospitals; system is aging	made to medical command at one of 6 hospitals; patched through to required hospital	UHF system with few dead spots thanks to system of repeaters	From Bend can reach only 30% of region because of mountainous territory

the context of trauma care, the triage decision usually means answering the question of whether the patient should be taken to a trauma center or not.

Triage of prehospital trauma victims requires identifying a threshold for injury severity or death risk so that the appropriate level of care can be readily accessed...

Early identification of the seriously injured patient presents a formidable challenge even to the most seasoned clinician, particularly in the adverse environment of the accident scene...Generally only limited information is available on which to base triage decisions, including:

- the physiological (clinical) status of the patient
- the nature and probable severity of the injury
- the type and availability of transportation
- the level, availability, and accessibility of hospital care.⁵

Figure 4-1 (taken from Cales & Heilig, Trauma Systems) presents a prehospital triage decision scheme.

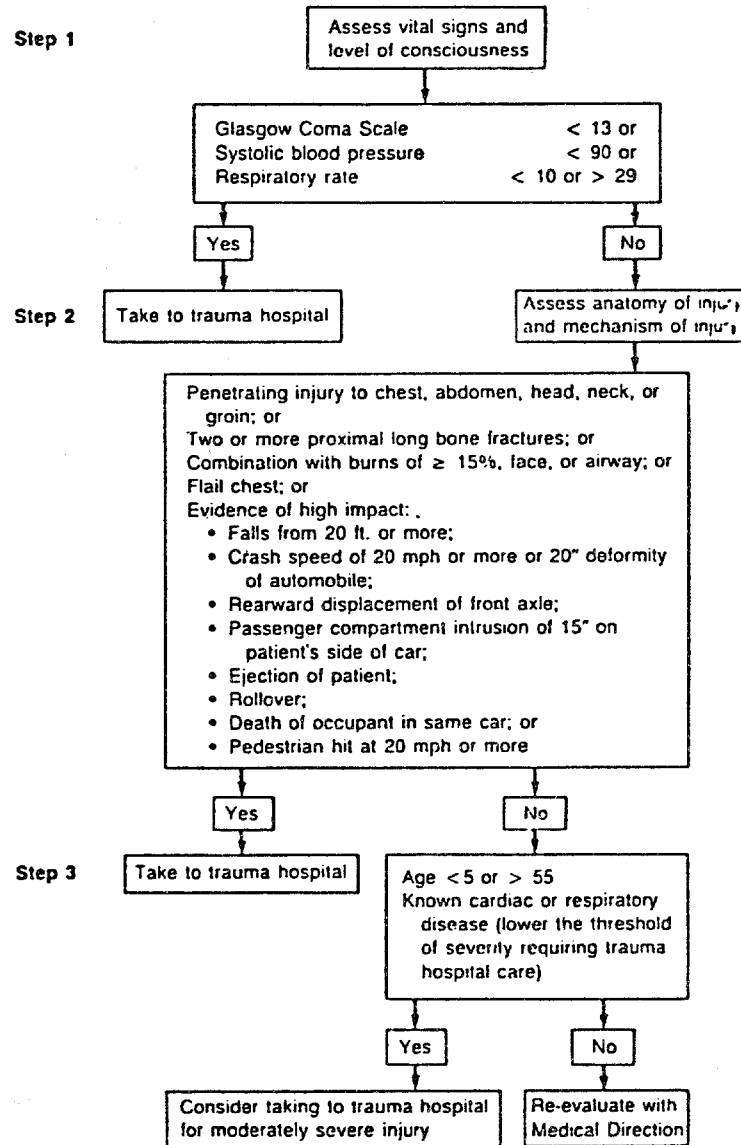
Trauma triage involves life-and-death decisions. Clearly, a physician schooled in trauma care would be the most knowledgeable person to make these decisions. For that reason it is important to have a physician in control of prehospital care, so that he/she can make decisions about the following:

- immediate transport vs. stabilization
- if stabilization, what procedures to implement (which must also be within the capabilities of the paramedic or EMT at the scene)
- what procedures to follow and what medications to administer during transport
- which hospital the patient should be taken to
- whether transport by helicopter (assuming one is available) is appropriate.

Medical control (if there is no physician at the scene) can be exercised via telecommunications and therefore in part depends on having a good and well-working communications system (see Section 4.2). Where there is no telecommunications system (or, if it fails or the ambulance is temporarily out of contact with the controlling physician), the EMTs or paramedics must rely on written protocols, written by the supervising physicians(s), which try to anticipate the conditions that EMTs/paramedics might run into and prescribe the appropriate course of action.

Figure 4-1

Prehospital Triage Decision Scheme⁶



When in doubt, take patient to a trauma hospital

From Cales, R. & Heilig, R., Trauma Care Systems. Reprinted with permission of Aspen Publishers, Inc. Copyright 1986.

We have already described the telecommunications systems that exist in the five areas that were visited. In this section, we shall therefore address only triage criteria and medical control in each of the five sites.

In Dade County medical control is exercised by either a physician at Baptist Hospital (for the MetroDade area) or by a physician at Jackson Memorial Hospital (for the city of Miami).⁷

Medical control communication is not required for all situations, but is required for certain drug treatments and for all severe trauma. Even if a patient is not being transported to Jackson Memorial Hospital, the paramedics will notify medical control at JMH, who will then notify the receiving hospital. Any arguments about which is the proper hospital to receive the patient will, therefore, be resolved between two physicians, not between a physician and a paramedic.⁸ Of course, with only JMH as a designated trauma center (except for pediatric cases), it seems that there will be no occasion for arguments concerning where a severely injured patient should go.

Protocols for the paramedics and EMTs were developed by the staff at Jackson Memorial Hospital and are uniform throughout the county. Revised triage criteria for transport to a trauma center became effective on November 1, 1986. They are as follows:

- (1) Systolic BP < 90
- (2) Glasgow Coma Score \leq 12
- (3) Paralysis
- (4) Major Burns (> 20% 2° and/or 3° burns)
- (5) Penetrating injury to head, neck, torso or groin
- (6) High index of suspicion for significant injury

(Examples: patient who bent steering wheel, not wearing seatbelt, complaining of chest or abdominal pain; ejection from motorcycle with long bone fractures; elderly pedestrian hit by vehicle with long bone fractures)

We have already called attention (in Section 4.1) to triage criterion 6 "high index of suspicion for significant injury," which gives considerable weight to the paramedic's judgment about whether to transport a patient to a trauma center or not. It no doubt leads to some overtriage, but a 20% overtriage is considered appropriate for a good trauma system.⁹

Medical control in Sacramento appears to be somewhat unstructured. (It must be remembered that the Sacramento County system is an interim system until a full system can be implemented.) Medical control is exercised by four base hospitals in the county (via UHF). The University of California Medical Center at Davis provides the medical control for Life Flight, its medical helicopter.

California law requires that the EMTs take a patient to the nearest appropriate hospital. EMTs make an evaluation of the patient at the scene, taking into account the Glasgow Coma Scale score, the Champion trauma score, and the mechanism of injury to the patient. There is no formal scoring system to determine whether a patient should go to the trauma center (UCD/MC). The EMT at the scene doing the evaluation of the patient communicates with the base hospital, and medical control there makes the decision as to whether the patient should go to the trauma center or not. This fairly loose system seems to work well enough, resulting, if anything, in overtriage to UCD/MC.

In the service area of the Eastern Pennsylvania Emergency Medical Services Council, there are strict guidelines for both physicians and paramedics, concerning medical command. An EMT Paramedic Protocol Manual exists which spells out the rules. The November 1985 revision contains a roster of 37 command physicians, located at six hospitals. Communication with the command physicians is via UHF. Below are excerpts from the guidelines for paramedics:

- (1) Upon arrival at the scene of an ALS call, the paramedic will make a rapid assessment of the situation. Should the paramedic feel that medical direction is needed (the parameters for this decision being spelled out by these protocols), they will establish communications with Medical Command and state their need for command...
- (2) When the Command Physician gets on the air, the paramedic will report his/her findings according to the established format. The physician will give whatever orders are indicated by the protocols...
- (3) If the Command Physician feels it is in the best interest of the patient, whether the patient has been stabilized or not, the physician may instruct the paramedics to move on to the receiving hospital...
- (4) The physician will remain available until it is determined that no further command is necessary or the patient has arrived safely at the receiving hospital.

- (5) If telecommunications cannot be established between an EMT-paramedic and a command physician in areas approved for ALS operations, or if such telecommunications, once established, are interrupted and cannot be re-established, the EMT-paramedic may initiate or continue care in accordance with...medical protocols established pursuant to Pennsylvania EMS Legislation (relating to medical protocols).

From the guidelines for physicians, from the same manual:

- (1) ...Command physicians can use discretion in the use of these protocols and order care which, in their medical judgment, is in the best interest of the patient(s) being provided with pre-hospital advanced life support care...
- (2) All orders will be in accordance with the established protocols...
- (3) Only approved physicians may give orders over the radio. All radio communications with the field are to be tape-recorded, in the event of medical-legal sequelae.
- (4) Decisions regarding the hospital of destination of any given patient will be made according to established guidelines. Command Physicians are not to direct the patient to any specific hospital, except in accordance with the approved EMS Regional Triage Guidelines. [These guidelines indicate that patients with minor trauma may be taken to any hospital in the region; patients with moderate trauma can be taken to any one of 14 hospitals; severe and urgent trauma cases should go to LVHC or to Reading Hospital.]

.....

- (7) With the exception of major trauma patients, the guiding principle of pre-hospital care is STABILIZATION OF THE PATIENT AT THE SCENE BEFORE THE TRANSPORT. The tendency to rush the critically ill patient to the hospital must be avoided. However, delay of patient care is also to be avoided.

Medical Control for the Panhandle region of Texas is located at Northwest Texas Hospital, in the AERC. Thanks to a system of repeaters, Medical Control is able to reach ambulances in any part of the Panhandle (with the exception of a couple of "dead" spots). The system has both transmission and reception capacity.

Supplementing Medical Control is a set of protocols (one for paramedics, EMT-SS, Pediatrics, and one for Basic EMTs). A revised set of protocols is going into effect September 1987. The following statement is from Protocol 1, Philosophy and Direction:

This protocol manual is divided into major categories of both medical and trauma related emergencies. Each category defines the initial procedure the paramedic will use in treating those situations, as well as recommendations for continued treatment per MEDICAL CONTROL approval.

The paramedic will contact MEDICAL CONTROL in all cases of medical or trauma related emergencies, for direction in the management of such emergencies. In some instances, the MEDICAL CONTROL physician may elect to direct treatment or intervention which varies from the suggested guideline. In that case, the paramedic is to follow the direction of the MEDICAL CONTROL physician.

Paramedics must be certified by the State of Texas, and must have authorized medical control numbers issued through the Panhandle Emergency Medical Services System in order to utilize these medical protocols. Once a medical number is issued, the paramedic must adhere to the standards defined in these protocols, or face revocation of medical control if those standards are violated.

Triage decisions are relatively simple in this area. Unless the transport distance is so large that the patient needs to be stabilized at a local hospital, serious trauma cases or those that appear to be so are brought to the Amarillo Emergency Receiving Center at Northwest Texas Hospital.

In eastern Oregon, given that there is as yet no trauma system in place, it is not surprising that medical control is only unevenly available. We have already noted, in Section 4.2, the communications difficulties that exist because of the mountainous territory. Triage is a problem: since there is as yet no hospital that is designated or categorized as a trauma center, transport is to the nearest hospital, though St. Charles, in Bend, is recognized as having the best trauma care facilities. If time permits, St. Charles is therefore the preferred receiving hospital for trauma.

The trauma system plan that Oregon has developed has very specific and stringent guidelines for medical control:

- (3) Medical Control
 - (a) Protocols, Policies and Procedures: Providers in each trauma system area shall function under one set of off-line pre-hospital trauma protocols and one set of on-line medical control trauma policies and procedures which address both basic and advanced levels of care. Off-line treatment protocols shall clearly describe all treatment and transport procedures and identify those procedures which require on-line medical authorization. Medical control policies and procedures must assure consistent data collection, simple prehospital access and catchment-area-wide quality assurance responsibility.

(b) Base Station: No more than one base station may provide on-line medical control within a catchment area at any time.

(c) Hospital Status: In the event of two or more categorized or designated facilities in a catchment area there must be a system in place for medical control to continuously determine current status of hospital trauma care capabilities.

(d) Physician Qualifications: On-line medical control physicians must be qualified for this role by virtue of training, experience and interest in prehospital trauma care as demonstrated through ACLS certification and ATLS training.¹⁰

The plan also addresses triage. There is a definite set of criteria, reproduced here as Figure 4-2, to decide whether or not a patient should go to a trauma facility. Note that these criteria and this decision scheme are almost exactly the same as those advocated by Howard Champion (see Figure 4-1).

The Oregon rules say this about triage and transport:

(4) Triage and Transport

(a) Transport: Transport protocols must be written which assure that patients who meet triage criteria as set forth in these rules [in Figure 4-2] will be transported directly to a regional (Level I) or area (Level II) trauma system hospital ... unless otherwise advised by on-line medical control or under the following circumstances:

(A) If unable to establish and maintain an adequate airway, patient should go to the nearest acute care facility to obtain definitive airway control by a qualified person.

(B) Local (Level III) hospital may be appropriate if the expected scene time and transport time to an area (Level II) or regional (Level I) trauma facility is greater than 30 minutes

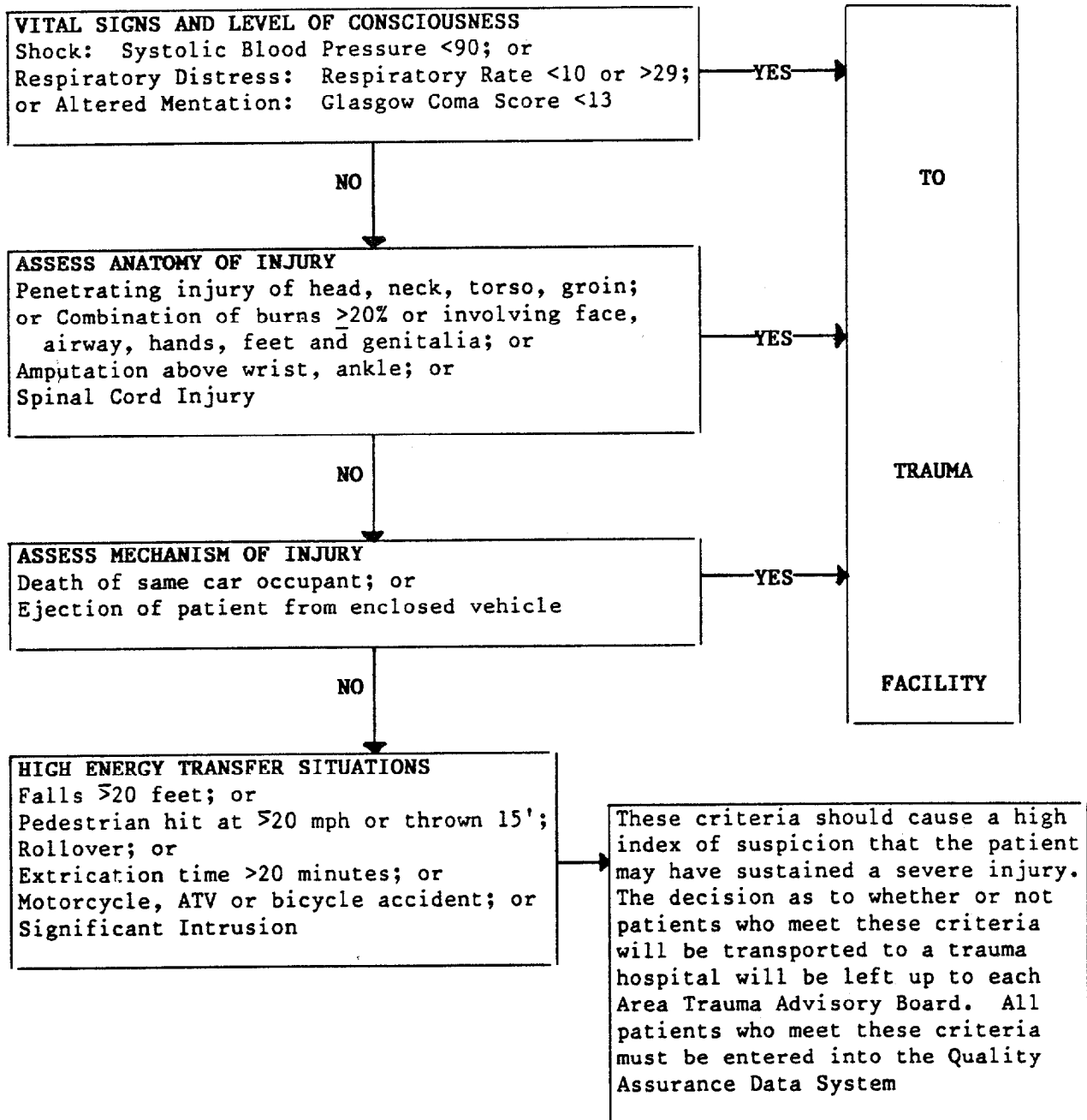
(C) Community (Level IV) hospitals may be appropriate for immediate evaluation and stabilization if the expected transport time to a local (Level III), area (Level II) or regional (Level I) trauma facility is greater than 30 minutes.

(D) Members of a health maintenance organization or other managed health care system may be transported to a hospital that contracts with these organizations when central medical control determines that the condition of the member permits such transport.

Figure 4-2

Oregon Triage Criteria

Decision Scheme



CO-MORBID FACTORS:

The following factors potentiate the severity of injury and should increase the index of suspicion:

1. Extremes of age (less than 12 or more than 60 years of age)
2. Hostile environment (such as extremes of heat or cold)
3. Medical illness (such as COPD, CHF, renal failure, etc.)
4. Presence of intoxicants

(E) Medical control should override these standards when appropriate, such as when a facility is unable to meet hospital resource standards as defined in... these rules, when there are multiple patients involved, or patients need specialty care.

(F) Application of paragraphs (B), (C), and (D) of this section should not unnecessarily delay medical or surgical treatment.¹¹

The rules clearly take account of the rural character of most of the state and the long transport distances. Although the decision scheme in Figure 4-2 may call for transport to a Level I or Level II trauma center, the rules recognize that more than 30 minutes may elapse to reach such a center. In that case, transport to a Level III center is appropriate; and, if the transport time to either a Level I, II, or III trauma center is expected to be more than 30 minutes, then transport to a Level IV center (community hospital) may be appropriate for immediate evaluation and stabilization. To make this work, much will depend on how quickly surgeons are available at a Level III or Level IV trauma center -- there is no point in saving time to reach such a center if there is long additional waiting time for a competent physician to arrive.

Table 4-3 summarizes triage procedures and medical control at the five sites which we studied.

4.4 Hospitals

Hospitals that are able to provide appropriate care are the linchpin of a well-developed trauma system. Some fraction of trauma patients never arrive alive at the hospital, of course: they are either dead at the scene or so severely injured that even an excellent prehospital system of care cannot save them. But for those patients that do survive long enough to be taken to a hospital, it is crucial that they arrive at the right hospital and in a timely fashion. "The objective of a trauma system is to get the right patient to the right hospital at the right time" (Donald D. Trunkey, M.D., quoted in Cales & Heilig, Trauma Care Systems, p.143).

There are three "rights" in Dr. Trunkey's sentence:

1. the right patient means that he/she has been properly triaged to need transport to a trauma center;
2. the right hospital means that the patient goes to a trauma center if she/he needs to, but does not go there if not necessary -- it is as important to avoid overloading trauma centers with cases who do not need to go there, as it is to make sure that they receive all those patients who do require their care.

Table 4-3

Triage and Medical Control in the Five Sites Visited

	Dade County, FL	Sacramento, CA	Allentown, PA	Amarillo, TX	Bend, OR
Are there written triage protocols for transport to a trauma center?	yes, with some room for paramedic discretion	Law requires transport to nearest appropriate hospital. In addition, there are written guidelines for transport of critical trauma patients.	yes, EMS Regional Triage Guidelines	no, all trauma goes to AERC	no, but plans for trauma system include guidelines
Who provides medical control?	trauma surgeon at JMH	base hospitals and UCD/MC	medical command at six hospitals	AERC	dispersed among hospitals, but plans call for on-line control

Mindless overtriage increases costs, overloads facilities, and creates hostility in other hospitals who view trauma centers as "stealing" patients. This destroys the possibility of there being a trauma "system" in which a variety of parts work together harmoniously.

3. the right time means quickly, within the golden hour, so that surgery can be performed if necessary to stop hemorrhaging. This may mean air transport if distances to the trauma center are long or if traffic conditions make quick ground transport infeasible.

Items 1 and 3 have already been talked about, in Section 4.1 and 4.3. Well-functioning EMS systems will reach a patient quickly, triage him/her properly, and expeditiously transport him/her to a hospital.

For a severely injured patient, that hospital should be a trauma center. Studies by Cales, Trunkey, West and others¹² have shown that trauma patients benefit (i.e., are less likely to die unnecessarily) if trauma care is regionalized; i.e., the resources of a region are pooled to provide appropriate -- and costly -- trauma care in one or a few hospitals, rather than being spread over a large number of hospitals of indifferent quality. Certain hospitals in such a region may then be categorized or designated as trauma centers (see Chapter 3 for legislation on the designation process).

Hospitals that are trauma centers may be designated as being of different levels. Different standards for designation as a Level I, Level II, or Level III trauma exist, but most of them are derived from, or close to, the standards set by the American College of Surgeons, Committee on Trauma.¹³ These standards, particularly for Level I's and Level II's are quite demanding and have financial implications for the hospitals so designated. (See Chapter 5 for a discussion of financial issues.) In a well-functioning trauma system, the right patient goes to the right hospital: this means that the most seriously injured patients go to a Level I hospital (if one is available); or to a Level II hospital. Level III hospitals do not offer the capabilities of a Level I or Level II trauma center, but can stabilize a patient and, if necessary, see to it that he/she is transported (perhaps by helicopter) to the regional Level I or Level II trauma center. If that is not necessary, a Level III trauma center can treat a trauma patient -- all within the caveat that a patient must receive appropriate care. This means that hospitals must cooperate with one another and must be integrated into a trauma system -- not keeping a patient who should go to a higher level hospital but also not flooding higher level trauma centers with cases that do not require such specialized care.

What we have said so far is based on the literature concerning trauma centers and trauma systems. Now let us look at what we found in our site visits.

Florida, as we saw in Chapter 3, does not designate trauma centers; instead, it verifies that a hospital meets standards for being a trauma center. Based on such a policy, in 1986 seven hospitals in Dade County had applied for verification as trauma centers and had been so verified:

- Jackson Memorial Hospital, the Level I Center and the county hospital;
- Mount Sinai Medical Center (in Miami Beach);
- Baptist Hospital;
- Hialeah Hospital;
- Mercy Hospital;
- Parkway Regional Medical Center (a for-profit hospital);
- South Miami Hospital.

In addition, there was (and still is) a pediatric trauma center. All but Jackson Memorial Hospital were verified as Level II trauma centers. At this writing, only Jackson Memorial Hospital and the Pediatric trauma center remain. The other hospitals have dropped out of the system.

The overriding reason for the collapse of the trauma system was financial. (See Chapter 5.) Other reasons that contributed were:

(1) It probably never made sense to have as many as seven trauma centers, particularly six Level II trauma centers, so close together. Except for the fact that they are not teaching and research hospitals, Level II trauma centers are held to almost the same standards as Level I trauma centers, but without having in house the staff of residents who can be used to provide the required 24-hour coverage. Level II trauma centers face large physician costs, therefore. There were just not enough trauma patients for seven hospitals, certainly not enough paying trauma patients.

(2) It appears that the hospitals rushed into participation for competitive reasons. One of the seven hospitals, viz. Parkway (a for-profit hospital operated by AMI) wanted to provide and pay for a medical helicopter. This was seen as an attempt to siphon off trauma patients to Parkway. The other six hospitals (all not-for-profits) joined together, opposed Parkway's helicopter plan and supported purchase of a medical

helicopter by the county. The county-wide trauma system of seven trauma centers was then set up to receive patients from the helicopter or ground ambulances.

(3) Another factor, perhaps irrelevant but perceived to be relevant, was the increase in malpractice insurance premiums for physicians, particularly surgeons and neurosurgeons. These specialty doctors felt very exposed in providing care in Emergency Departments because, they said, in such a setting there is not time for a patient-doctor relationship to develop. Hence, if all goes not to the patient's liking, he or she is likely to sue the doctor. For this reason, some surgeons and neurosurgeons refused to see patients in the Emergency Department (even after being assured that their doing or not doing so would have no impact on their premiums). Without these doctors, the hospitals were unable to meet the standards for a Level II trauma center and so left the system.

At the time of our site visit, the system was not yet in total disarray, although well on its way. Personnel at Jackson Memorial Hospital (JMH) thought that the ideal trauma system for Dade County would be three or four trauma centers: JMH as Level I, Parkway in the north as a Level II, and Baptist in the south also as Level II. In addition, Mt. Sinai Hospital (located in Miami Beach) would be useful to have because of its ability to provide care in that part of the county. In addition, there needs to be a pediatric trauma center (as there is at Miami Children's Hospital). Nevertheless, the personnel at Jackson Memorial Hospital also thought that if necessary they could handle the entire trauma load for the county and saw that as a benefit to their teaching function.

Overall, it appears that the seven hospitals in Dade County never functioned as a trauma system, but merely as a collection of competing trauma centers. The cause is probably weak state legislation, as well as insufficient provision of methods to reimburse hospitals for care of indigent trauma patients. The legislation setting up the verification process mandates that trauma centers treat all patients, but makes no provision as to how hospitals are to get paid. Jackson Memorial Hospital, as the public hospital, enjoys some county funding; the other hospitals, even if they treat "county" (i.e., indigent) patients, do not.

In California, as we saw in Chapter 3, there exists strong legislation concerning the establishment of trauma care systems. Below is an overview of how one trauma system in California is reported to work. The system being described is that in San Diego County. The Sacramento system, it must be remembered, is an interim system, soon to be replaced by a full-fledged system. The interaction of the various

system parts as described in the San Diego overview is probably a close approximation to how this occurs in any good system (see, for example, the Allentown system):

Patient identification begins with the activation of the EMS system. Optimally, a call is placed to a local law enforcement agency, through the regional 911 matrix, requesting emergency assistance. This call triggers the simultaneous activation of a first responder and an ambulance. The first responder, typically trained to the EMT-I level, arrives at the scene and makes the initial patient assessment. Upon arrival of the transporting unit, emergency personnel (EMT-I's or Paramedics) contact the trauma center, if the patient's needs or mechanism by which he is injured indicate that the person could be a trauma center candidate. In communication with trauma base hospital personnel, triage, treatment and transport decisions are made to assure that the injured patient receives optimal prehospital care.

Information regarding this phase of the trauma system is typically generated on both the prehospital Patient Record and the Trauma Registry. Both information sources are used to maintain effective oversight regarding prehospital care and provide feedback and case identification data for the System Advisory Committee and Medical Audit Committee....

Transportation decisions are based upon patient needs and available hospital resources. Most frequently, major trauma candidates are transported to the nearest designated trauma center.

Under the standards, approved by the County Board of Supervisors, designated trauma hospitals are required to have available certain necessary resources and manpower upon arrival of the major trauma patient. With the option of either taking the patient directly to the operating room or managing the patient in the resuscitation area, the trauma facility provides state of the art trauma equipment and highly trained physician and nurse specialists -- all committed to rapid medical and surgical intervention, as necessary.

The inhospital phase of care, for each major trauma patient, is documented on a Trauma Registry and transmitted to the Division of Emergency Medical Services...¹⁴

Notice that the overview speaks of "designated" trauma centers, as contrasted with Florida. (In San Diego, there are six trauma centers.)

The interim system in Sacramento County was able to be set up in just three months, since it was understood that the system would be amended and if necessary corrected as needs became apparent. The initial thought was that the system should comprise three trauma centers: one in the downtown Sacramento area, one in the northern part and one in the southern part of the county. However, only the University of California, Davis Medical Center (UCD/MC) was designated by the County Board of

Supervisors as a trauma center. "UCD/MS agreed to meet American College of surgeons" Level II criteria (emphasis added).¹⁵ Although this was a non-exclusive designation, no other hospitals were able to meet the physician staffing requirements for designation.¹⁶ Staffing requirements would have meant having surgeons available in-house; apparently many physicians in California were unwilling to provide this service without quite a large payment. If the ACS standards could have been relaxed to permit surgeons to be available on 20-30 minutes call, other hospitals would have been willing to be designated as Level II trauma centers.

With only one trauma center, that center (UCD/MC) receives almost all of the trauma cases in the county, including those that need not go to a trauma center (by December 1987, over 3,000 trauma cases per year were estimated to go to the Medical Center). Over-triage of perhaps 30-40% is estimated.

The evaluation of the interim system provides some other data: During the six months from July 1, 1985 - December 31, 1985, 565 trauma patients were treated by the EMTs. Of these, 236 were classified as "major trauma patients," though the report later on states that there is no clear definition of what "major trauma" is. It lists the geographic incidence of the trauma cases, which indicates that if there were to be another trauma center in the county, it should be in the northern part. Ambulance times are discussed, including the "excessive on-scene time"¹⁷ for the ambulances.

Of special interest is the review of preventable deaths. There were 64 trauma deaths during the six months (July-December 1985) which the report covers; only one of these was judged to have been preventable. During the four months from January 1, 1985 to May 1, 1986, there were seventy-five trauma deaths; none of these was considered preventable.

The report contains several recommendations, indicating that though the interim trauma system appears to be saving lives, there is still room for improvement. Among these recommendations are the following:

1. The standardized definition of major trauma for inclusion in retrospective review should be adopted and implemented as soon as possible.
2. Base hospitals should emphasize the need for quick transportation of major trauma patients with all but an absolute minimum of pre-hospital functions performed while enroute to the trauma center. To further promote this, advanced life support functions on major trauma calls should be performed under direct medical control.

3. The University of California, Davis Medical Center, should continue to develop policies and procedures for the Trauma Service which recognize the inter-disciplinary nature of trauma care.

.....

7. A trauma review committee should be established to review cases identified as not meeting standards and should include representatives of the trauma center, non-trauma center hospitals, and S-SV EMS. It should review cases of apparent non-compliance and trauma deaths at non-trauma center hospitals. A sample of deaths at the trauma center should be reviewed for preventability.¹⁸

It is clear that the interim system would benefit from a second trauma center, particularly in the northern part of the county. The logical hospital to apply for such status is Mercy San Juan Hospital. But while this hospital initially had expressed some interest in being designated as Level II trauma center, Mercy San Juan now expresses little interest.

The interim character of the system in Sacramento makes it difficult to arrive at a definitive judgment about how well it serves trauma patients. The legislative environment exists for a well-functioning system, but other factors have yet to be resolved at the local level in order to make use of the legislative support.

As noted in Chapter 3, Lehigh Valley Hospital Center (LVHC) was the first hospital designated by the Commonwealth of Pennsylvania as a trauma center in 1981. Even before state designation, Lehigh Valley Hospital Center had begun its commitment to the provision of trauma care. The establishment of LVHC grew out of a partnership between the two largest hospitals in the Allentown area--Allentown General and Sacred Heart. Both are urban hospitals that, during the late 60s and early 70s, were proposing to expand. Through the health planning process it was decided that a single expansion through a partnership would be an appropriate step. Through the merger process, services were "allocated" to each of the three hospitals. For example, Allentown General closed its Emergency Department, leaving Sacred Heart the urban ED in the group. The new hospital (LVHC), located several miles from the city center, opened an Emergency Department. The new facility was designated to be a regional tertiary care center, and included, from the beginning, open heart surgical services and neurosurgical services. Sacred Heart Hospital gave up its neurosurgery to the new facility.

The development of a trauma service was planned as the new hospital was being established in 1974. The fact that LVHC had capacity to provide high-tech cardiac and neurosurgical services made the development of trauma care a natural

activity. This early involvement included the design of hospital facilities in a way that facilitated trauma care--with a helipad close to the ER entrance, a resuscitation area, and easy access to hospital operating rooms. (Recently the hospital added a 12-bed Intensive Care Unit right next to the resuscitation room.)

A major factor in the success of the Eastern Pennsylvania model is the close coordination between the hospital as it developed its trauma care capacity and the EMS Council, which appears also to be particularly aggressive in its support of EMS development. The cooperative approach between LVHC and the EMS Council is demonstrated in the development of the helicopter transport service. Although the helicopter is funded fully by the hospital, from its inception LVHC sought support for its use from the EMS Council. In return for its support, the Council placed 28 conditions on the helicopter program. Recognizing that the helicopter service was seen as a threat by surrounding facilities, the Council insisted that all helicopter cases be reviewed quarterly by a committee composed of physicians from surrounding hospitals.

Also as one of its conditions for operation, the LVHC takes "visiting residents" from surrounding hospitals for rotation on the Trauma Service, thus providing educational experiences at the medical level as well.

One factor leading to the stability of the trauma system is the fact that it produces a positive cash flow for LVHC. While inner-city centers struggle with the problems of the uninsured "knife and gun" club, this center is located in a region with a high percentage of insured residents. The general payor mix of the hospital overall includes 43% Medicare, 50% Blue Cross or commercial payors, and just 2.5% Medicaid and 2.5% self-pay (which frequently become bad debt). For the trauma service, in a 1984 sampled period, 30% patients had charge-paying coverage, 29% had Medicare, 1% self-pay, and 36% Blue Cross. Some of this is attributed to the fact that Pennsylvania law mandates auto insurance and this is the first payor in cases of motor vehicle crashes. A current potential problem is that the introduction of "no fault" coverage may decrease the extent of coverage available for accident victims.

Overall, the Allentown area has an excellent trauma center in Lehigh Valley Hospital Center. Although there is some tension, there appears to be a spirit of cooperation between LVHC and the other hospitals. There is also a strong EMS council to unify prehospital and hospital care.

There are no Level II trauma centers in the region. This means that trauma patients in outlying areas (such as Schuylkill County) have to rely on helicopter

transport in order to obtain appropriate care. EMTs and paramedics are under medical command at all times, but there is not one medical control, but six (one at each of six hospitals). There are no formal bypass agreements among the hospitals, although some paramedics tend to take trauma patients to LVHC on their own.

Northwest Texas Hospital (NETH) in Amarillo functions like the designated trauma center for the Panhandle region. All serious trauma patients are taken there; ambulances bypass rural hospitals that are nearer to the scene of the emergency in order to take patients to NETH. Texas' Emergency Medical Services Act provides that an injured person be taken to the nearest appropriate facility; in the Panhandle, this usually means Northwest Texas Hospital.

However, NETH does not meet the standards of the American College of Surgeons for a Level I or Level II trauma center. Although it is affiliated with the medical school of Texas Tech University and is a teaching hospital, there are no surgical residents from Texas Tech at NETH. (Surgeons trained at Texas Tech do their residencies at Lubbock.) Furthermore, it does not have a trauma team under the direction of a surgeon who takes responsibility for the patient with serious and multiple trauma. It does not have available, in house and 24 hours a day, a general surgeon and a neurosurgeon nor the other surgical specialties that the American College of Surgeons' Hospital Resources Document calls for.

The Amarillo Emergency Receiving Center (AERC) is the emergency department of Northwest Texas Hospital. AERC was set up in 1972 by a formal agreement among the three major hospitals. Having just one emergency department in the city was felt to be the best use of medical resources. Emergency patients are therefore always taken to AERC, unless they specifically request transport to another hospital or their doctor does (and the medical condition of the patient permits this). (Almost all of the approximately 300 physicians in the Amarillo area have admitting privileges at all three hospitals.) NETH supplies the nursing staff and the equipment of AERC, but contracts for the physicians' services with a separate group of physicians. The various surgical and other specialty services that are needed are provided by private physicians who are on-call. An on-call roster is maintained listing for each day which physician is on call for which specialty. It is the duty of the on-call physician to make alternate arrangements if he/she cannot be on call on a day for which they have been designated.

Obviously, the provision of appropriate care for trauma patients is crucially dependent on the functioning of the call roster. Because of the good communications

system that is provided by Panhandle Emergency Services, paramedics can alert medical control at NWTH, while the ambulance is en route to the hospital, that a trauma surgeon or neurosurgeon (or any other specialty) will be needed. Medical control and the on-duty AERC physician can then call the appropriate physician on call; the latter is often at the AERC when the patient arrives or shortly thereafter. If, however, the call roster system fails -- i.e., if physicians do not respond in a timely fashion, or refuse to respond, or if so few physicians are willing to sign up for the roster that the burden on the remaining physicians becomes intolerable -- then patient care will suffer.

Several informants reported that the call-roster system does work, although some pressure has had to be applied to the attending private physicians to sign up for the roster so as to keep it viable; at one point only five or six physicians were willing to take calls. Not only would this make it very difficult for patients to receive appropriate care in the AERC, but it would also make it difficult for those that need it to be admitted to the hospital. All admitting has to be done by the private physicians who are on the staff of NWTH. This has the advantage of removing the element of economic competition between AERC physicians and private attending physicians: the latter need not fear that the AERC physicians will make some of the emergency patients "their" patients and so keep revenue from the attending physicians. On the other hand, it again points up the importance of surgeons, neurosurgeons, etc. being on the call roster and responding quickly if they are called.

There are two other major hospitals in Amarillo, St. Anthony's and High Plains Baptist (there is also an osteopathic hospital and a veterans hospital). Each of the three major hospitals has carved out its own domain of expertise and specialization: Northwest takes care of trauma and does almost all of the obstetric, pediatric, and neonatal work; High Plains Baptist does ophthalmology and cardiac catheterization; St. Anthony provides most of the cardiac care, orthopedics, nephrology; it also has a hospice. Northwest Texas Hospital is the city hospital (actually it is operated by the Amarillo Hospital District which encompasses parts of both Potter and Randall Counties, because the City of Amarillo is located in both counties). As such, Northwest Texas Hospital provides medical care for indigents (and is reimbursed by the Hospital District for such care). However, in Texas "indigent" refers only to persons who have been officially so designated by the county because they meet certain income guidelines. Other persons, like the so-called "working poor," may not have sufficient

income to pay for medical care. NWTH is not reimbursed for their medical care; rather, this becomes part of their "bad debt" burden.

Of the three hospitals, Northwest Texas has the highest occupancy rate, approximately 85% according to the hospital's chief financial officer. The other two hospitals hover around a rate of 50%. NWTH's high occupancy rate is reported as being in part due to AERC. There were about 10 hospital admissions per day from the AERC. This is one reason why hospital administrators support the AERC and the hospital's role as the "trauma center" even though the hospital probably loses money on the AERC. It does, however, keep the hospital's beds filled.

In the Texas Panhandle, therefore, we have a situation where there is no true system of trauma care, although trauma care is available at Northwest Texas Hospital. The rural hospitals realize that they cannot provide the needed kind of care, so there is no difficulty in ambulances by-passing these hospitals and going to NWTH. Care would be more assured, of course, if there were a medical helicopter, since the geographical area is so large (over 25,000 square miles).

There are two potential problems: first, will the state of peace between the three hospitals in Amarillo continue, or will the other two institutions--faced with low occupancy rates and looking at NWTH's 85% occupancy rate--want to have some share of the admissions that come from the Emergency Department? In July of 1987, St. Anthony's offered to buy Northwest Texas Hospital. The offer was not accepted by the hospital district and things remain as they were. Nevertheless, this may have been a sign that economic pressures are at work that may disrupt the harmonious relationship between the hospitals.

Second, the smooth operation of AERC depends on the continuing functioning of the on-call roster. If the private physicians in Amarillo should ever fail to keep that roster filled or fail to respond quickly to calls for emergency trauma care, then the present system would obviously not be viable. Such failure would seem to open the door for state-mandated designation of a trauma center, with all the attendant responsibilities as well as privileges becoming a matter of law rather than custom.

Oregon does not yet have a trauma system but is in the process of setting one up. The plan for the trauma system has been described in Chapter 3.

There are six hospitals in the area of Trauma Advisory Board Seven, which includes Bend. St. Charles Medical Center in Bend is the largest (164 beds) and is expected to be categorized as a Level II trauma center. Redmond Hospital (67 beds),

only 16 miles from St. Charles, will apply for Level III categorization. This of course does not solve the problem of hospital trauma care for the outlying areas away from Bend. It is not known whether any of the other hospitals expects to be categorized as a Level IV trauma center -- the special category created in Oregon to meet rural needs.

The following is a list of the qualifications that are essential for a Level IV trauma center:

Emergency Department staffed by qualified specialists.

Anesthesiologist or certified registered nurse anesthetist, on-call and promptly available.

Physicians who are qualified and experienced in caring for patients with traumatic injuries and who can initiate resuscitative measures.

Emergency physician trained in ATLS, on-call and promptly available.

Emergency Department Registered Nurse trained in ACLS, in-house and immediately available.

Equipment for resuscitation, including airway control and ventilation equipment, suction devices, electrocardiograph-oscilloscope-defibrillator, apparatus to establish central venous pressure monitoring, all standard intravenous fluids and administration devices, sterile surgical sets for procedures standard for ED, gastric lavage equipment, drugs and supplies necessary for emergency care, two-way radio linked with vehicles of emergency transport system, pneumatic anti-shock garment, skeletal traction device for cervical injuries.

Organized burn care.

Acute spinal cord injury management capability.

Physician-directed rehabilitation service or transfer agreement to a nearby rehabilitation service.

Operating room adequately staffed and equipped for trauma care promptly available.

Operating room equipment including thermal control equipment for patient and for blood, x-ray capability, monitoring equipment.

Clinical Laboratory services available 24 hours a day, including standard analyses of blood, urine and other body fluids, blood typing and cross-matching, coagulation studies, comprehensive blood bank or access to a community central blood bank and adequate storage facilities, blood gases and pH determinations, microbiology, serum alcohol determination.

Full participation in the Division Trauma Registry and quality assurance activities as prescribed in the area plan.

Designated trauma registry coordinator.

Standards for other level trauma centers follow those of ACS.

Because of the configuration of the hospital industry in the region, most respondents report that the development of a trauma plan will not substantially change the approaches used currently in handling the critically injured. At present, most seriously injured patients are referred to St. Charles. On the other hand, a number of respondents stated their concern that the trauma standards and triage model will result in many patients being referred to St. Charles who could be treated adequately in the neighboring hospital emergency rooms.

Table 4-4 summarizes the facts concerning hospitals in the five sites.

4.5 Quality Assurance

The Committee on Trauma of the American College of Surgeons writes:

A trauma center must have a firm commitment to strive continually for optimal care. Only by evaluating its performance in the care of the trauma patient can a trauma center be assured that this commitment to excellence is actually being achieved. Actions that support optimal trauma care include: Mortality and morbidity reviews, multidisciplinary trauma conferences, medical-nursing audits, tissue reviews, and trauma-related educational programs...

A trauma center quality assurance program is a planned and systematic method of evaluation, which measures the center's degree of compliance with selected optimal trauma care standards. Such a program examines critical elements in optimal trauma care and is essential to measuring trauma center performance.¹⁹

A well-functioning quality assurance program clearly benefits the trauma patient -- making certain that he receives the optimum care that is available under the circumstances. Quality assurance also is important from the researcher's point of view: it enables us to discern whether a region has a true trauma system or whether there is one in name only.

The Florida Trauma Care Act states that local or regional trauma agencies are to develop plans for trauma medical services systems. One of the components of such plans is quality control and system evaluation. If there are no local or regional agencies, the Department of Health and Rehabilitative Services will develop such

Table 4-4

Hospitals in the Five Sites Visited

	Dade County, FL	Sacramento, CA	Allentown, PA	Amarillo, TX	Bend, OR
Is there a Level I trauma center?	yes, Jackson Memorial Hospital	no, UCD/MC is a Level II (though it could meet Level I standards.	yes, Lehigh Valley Hospital Center	no	no
Are there Level II trauma centers?	There were six, now there are none.	one, UCD/MC; hoping that Mercy San Juan may apply for designation	no	no	St. Charles expects to apply
Where are serious trauma patients taken?	Jackson Memorial Hospital	UCD/MC	Lehigh Valley Hospital Center	Amarillo Emergency Receiving Center at NWH	St. Charles
Does the state designate trauma centers?	no, it verifies compliance with standards	state has delegated authority to counties or EMS regions	no, state has set up Pennsylvania Trauma Foundation to accredit trauma centers	no, there is at present no state authority for designation	the Health Division of the Department of Human Resources will either designate or categorize trauma centers

trauma care plans. Again, quality control and system evaluation is one of the items that is to be included in these plans.²⁰ Nothing is said, however, as to how quality control or assurance is to be implemented.

Dade County has a trauma registry. It receives input on trauma cases from the fire rescue squads' reports, from the hospitals, and from the medical examiner's office. Basically, quality assurance is done by the head of the trauma registry. The registry includes all trauma cases that are triaged to a trauma center (according to the six triage criteria of Dade County) or any case that is classified by a hospital as trauma.

The trauma registry collects and publishes a variety of statistical information such as:

- distribution of patients in registry

- by age

- by sex

- by race/ethnic group

- by incident cause

- by reason included

- by initial disposition

- by month

- distribution of trauma cases by hospital
- initial disposition of patients by triage criterion.

Other data include, for example, financial data on trauma patients that indicate both charges and collected amounts.

A trauma registry, though an important part of quality assurance, does not by itself provide quality assurance, of course. Jackson Memorial Hospital -- now the only part left of the original trauma system -- has its own quality control. There is a weekly Mortality and Morbidity meeting, attended by the trauma team, attending doctors, students, and the trauma nurse.

Each of the five fire rescue squads also has some system of quality assurance: cases are reviewed once a month, by the medical director of the EMS service or by the fire captain or by someone else, such as a registered nurse. The head

of the trauma registry also notices cases that may not have been handled properly and calls them to the attention of the medical director of a service or of the fire chief.

What appears to be lacking, however, is a unified quality assurance program for the entire trauma system that would assure that the proper trauma care is administered everywhere in the system -- at the scene of an emergency, during transport, at the emergency department, in the hospital and during the rehabilitation phase.

California legislation is also non-explicit on quality assurance procedures. In discussing medical control, the Health and Safety Code notes that the medical director of an Emergency Medical System shall maintain medical control. Retrospectively, such medical control is to be exercised by means of medical audit of field care.²¹ As for a trauma system, the Code requires that the state Emergency Medical Services Authority adopt regulations covering, among other things, case load, qualifications of health care personnel (including physicians and surgeons), data collection regarding system operation and patient outcomes, and periodic performance evaluation of the trauma system and its components.²²

The Sierra-Sacramento Valley EMS agency has developed a trauma care system plan. This is a plan for the entire region, not just for Sacramento County which is the only participant in the "interim" system that was in place during the site visit. The plan contains careful and detailed regulations for quality assurance. It is to be achieved through three activities:

- Each trauma center must have an internal quality assurance program, including audits of all trauma-related deaths, and a monthly multi-disciplinary trauma conference to critique selected trauma cases.
- Setting up a regional trauma registry
- Review of preventable trauma deaths and other problem cases (identified either by the trauma center or by the registry) will be done by a regional trauma review committee.

This is a plan for the future, since the SSV trauma care system is not yet in place. In the existing interim trauma system, quality assurance appears to rest mostly in the University of California Medical Center. The Center has a plan for internal quality assurance mechanisms, to review trauma cases that are flagged by various filters as being worthy of review. There is also the weekly Mortality and Morbidity conference that is standard in all hospitals, as well as a variety of monthly reviews.

There are also mechanisms for data collection for a trauma registry. At the time of our site visit, however, no trauma registry was in operation, largely, we were told, for financial reasons.

The interim system does not appear to have a system-wide quality assurance plan. UCD/MC has its system and the SSV-EMS system seems neither to have access to it nor to have much of a quality assurance system of its own. At the time of our site visit, the director of SSV-EMS wanted to move toward the San Diego model of quality assurance. Thus he was hoping to set up a Medical Audit Committee with membership from several hospitals (see below). Every trauma death is, of course, autopsied -- that is required by California law.

Overall, it seems that better communication is required between the EMS agency and the trauma center in order to have a really effective quality assurance system in place. The current system, where each party goes its own way, may be due to the interim nature of the Sacramento County system; thus once the permanent system is installed, there may be improvements.

Here is how the 1987 Annual Report describes quality assurance in San Diego County:

Quality Assurance of the entire trauma system is maintained by the monthly review of select trauma cases. The EMS Division, having developed and promulgated Trauma policies and procedures, staffs and supports both the Medical Audit Committee (MAC) and the System Advisory Committee (SAC).

Medical Audit Committee:

The Medical Audit Committee (MAC) is a confidential advisory committee designed to monitor and evaluate the medical care of patients with traumatic injuries. This Committee is comprised of:

1. Physicians and nurses from the designated Trauma Centers
2. Physicians representing the San Diego Societies of Emergency Physicians, Anesthesiologists, Neurosurgeons and General Surgeons
3. The President of the San Diego County Medical Society
4. The County's Chief Pathologist and Deputy Coroner
5. Key Emergency Medical Services (EMS) staff.

This Committee meets monthly to review all trauma deaths and select cases which represent possible deviations from standards or excellent examples of the trauma system in operation. These activities

represent the quality assurance and professional educational component of the MAC Committee. Deliberations of the Committee are confidential, specifically covered by Section 1157.7 of the California Evidence Code and are exempt from discovery and disclosure. As an extension of the EMS Division, MAC assures medical and surgical quality within the trauma system.

System Advisory Committee:

When the County of San Diego initiated the regional trauma system, the need for a nonmedical system advisory body to augment the Medical Audit Committee was recognized. This System Advisory Committee (SAC) was conceptualized to advise on issues affecting the overall trauma system.

This Committee is comprised of representatives of the following:

- San Diego County Fire Chiefs' Association
- San Diego County Medical Society
- Emergency Medical Care Committee
- Medical Audit Committee
- Emergency Nurses Association
- Chairperson of Prehospital Subcommittee (presently, the Aeromedical Representative)
- Chairperson of the Hospital Subcommittee (presently, the San Diego Emergency Physicians' Representative)

This Committee meets monthly to evaluate trauma audit summaries, trauma center bypass data, aeromedical activity, communications problems, and other problems referred from MAC.²³

In Pennsylvania, the Department of Health, as the lead agency for emergency medical services, has the authority to "maintain a quality assurance program for the purpose of monitoring the delivery of emergency medical services" and "compile and maintain statistics on mortality and morbidity on multisystem trauma victims."²⁴ Furthermore, in describing what the Pennsylvania Trauma System Foundation is to do, the same act requires that the Foundation's accreditation standards for Level I and Level II trauma centers include for a Level I trauma center that "600 severe and urgent injury cases have been treated per year" and for a Level II trauma center that "350 severe and urgent injury cases have been treated per year."²⁵ Such caseload requirements may themselves further quality of care since they prevent skill decay in the trauma center personnel.

Quality assurance in the prehospital setting appears to be working quite well in Allentown and in the Eastern Pennsylvania Emergency Medical Services Council's catchment area. One of the two medical co-directors goes over every ALS report

(about 900 a month) and has instituted rather rigorous procedures that require answers in writing by the paramedics for all apparent deficiencies.

There is a trauma registry, containing information on patients from 1979-1987. Information comes from Emergency Room records, medical records and from helicopter records. The registry does not keep the ambulance run reports, but does see them before they are filed. Data from the registry are used for the trauma mortality conference and for reviews of helicopter transports (all helicopter transports are reviewed quarterly by a committee of physicians from hospitals surrounding Lehigh Valley Hospital Center). Thus, there are quality assurance procedures for the parts of the system, but no quality control of the system as a whole.

In the Texas Panhandle region, quality assurance is performed for the prehospital care by the medical director of Panhandle EMS (who is also the head of Northwest Texas Hospital's Amarillo Emergency Receiving Center). Paramedics' and EMTs' performance is reviewed by the medical director based on the run reports which he reviews. He meets with the paramedics and EMTs in the region on a more or less regular basis and advises them where he thinks different kinds of action might have been more appropriate and responds to their questions.

There is no trauma registry in Amarillo. The same bill which would have mandated designation procedures for trauma centers also would have mandated trauma registries for the state; this bill, of course, did not pass.

Quality assurance at Northwest Texas Hospital is handled by the Emergency Care Committee; it is based in the Department of Surgery which appoints its members. Emergency room charts are reviewed every 24 hours, using criterion-based screens. For trauma surgery, surgical quality review screens are used as mandated by the JCHA. All DOAs are reviewed monthly.

Given the lack of legislatively mandated action on trauma centers and trauma systems, there is no system-wide unified quality assurance. Rather, prehospital and hospital care each have separate procedures for quality assurance.

In Oregon, the Trauma System rules prescribe quality assurance procedures in considerable detail, including a system-wide audit, prehospital care audit and hospital care audit with different criteria for review for Level I and Level II hospitals on the one hand, and Level III and Level IV hospitals on the other.²⁶

Cases that need to be reviewed include false positives and false negatives, i.e. patients who needed to go to a trauma system hospital but were not directed to one or

were directed to a hospital in the system that was not prepared to receive them, or patients were directed to a trauma system hospital but did not need to go there.

Criteria for cases that need to be reviewed for prehospital care include, among others, excessive ambulance time at the scene, patient dead at the scene, patients transported by air.

Criteria for hospital cases that need review include trauma deaths, long emergency department time, excessive ICU days, absence of trauma surgeon in the emergency department when the patient arrives (for severely injured patients) etc. Criteria differ only slightly for Level I and II hospitals from criteria for Level III and IV hospitals.

As with other Oregon standards, it remains to be seen how well these excellent standards can be and will be implemented, particularly in the rural settings of the state.

Table 4-5 summarizes quality assurance procedures in the five sites.

Table 4-5

Quality Assurance in the Five Sites Visited

	Dade County, FL	Sacramento, CA	Allentown, PA	Amarillo, TX	Bend, OR
Is there system-wide quality assurance?	no, only at Jackson Memorial	no, only at UCD/MC	yes	no	planned but not yet implemented
Is there a trauma registry?	yes	no	yes	no	no

NOTES

1. The information in this and the following sections is based not only on our site visit in February of 1987, but also on notes taken by GAO staff during their visits in 1986 in preparation for the GAO report. We gratefully acknowledge GAO's courtesy in providing us access to these staff notes.
2. Evidently, a great deal of thought and care went into the purchase of the helicopter, which cost \$2.9 million. Consideration was given to the weight which the helicopter would have to lift (pilot, co-pilot, flight-medical, two paramedics and one or more patients), to the likelihood of 90°+ days in the Miami area (which decrease lift), and to the safe operation of the aircraft in terms of having a sufficiently large number of crewmembers. Helicopters, though very glamorous and what the public often thinks of when "EMS" or "paramedics" are mentioned, are also difficult to fly. In recent months there has been some adverse publicity for medical helicopters, because several crashes have been reported which appear to be due, at least in part, to crew fatigue. MetroDade determined that for safe 24-hour operation of the helicopter, a crew of nine would be required (including a non-flying chief pilot).
3. Sierra-Sacramento Emergency Medical Services Agency, Evaluation of Operations of the Sacramento County Interim Trauma System, August 1986, pp. 8-9.
4. Steadman's Medical Dictionary, 24th Edition. Baltimore, 1982: Williams & Wilkins, entry "triage."
5. Howard R. Champion, "Triage" in Cales, R. & Heilig, R., Trauma Care Systems, Rockville, MD, 1986: Aspen Publishers, Inc., p. 82.
6. Cales & Heilig, op. cit., p. 102.
7. This was the situation in 1986. It is not known whether Baptist Hospital still provides medical control for MetroDade paramedics, after the collapse of the trauma system.
8. From GAO staff notes on Advanced Life Support.
9. Champion, op. cit., pp. 106-107.
10. Oregon Trauma System, Proposal Rules, Standards 333-200-080. pp 14-15
11. ibid., pp. 15-16.
12. See Literature Review, pp. 14-21.
13. American College of Surgeons, Hospital and Prehospital Resources for Optimal Care of the Injured Patient and Appendices A through J, 1986.
14. County of San Diego, Trauma System Annual Report, January 1987, p. 34.
15. Evaluation of Operations of the Sacramento County Interim Trauma System, August 1986 (prepared by the Sierra-Sacramento Valley EMS Agency), p. 2.

16. UCS/MC actually was certified as a Level I trauma center by the American College of Surgeons some years ago (ACS no longer certifies trauma centers lest they be found to be in restraint of trade). The Sacramento Board of Supervisors was only looking for Level II trauma centers and had hoped that several hospitals would apply and could be certified. However, as the text says, only UCD/MC was able to meet the staffing requirements even for a Level II trauma center.
17. op. cit., pp. 8-9.
18. op. cit., pp. 15-16.
19. op. cit., Appendix G, p. 42.
20. Florida Statutes, "Trauma Care Act," Section 395.031 (2)(b)14 and Section 395.032 (2)(n).
21. Health and Safety Code, Division 2.5, Chapter 5, Section 1798.
22. ibid., Chapter 6, Section 1798.161.
23. County of San Diego, Trauma System Annual Report, January 1987, pp. 35-36.
24. Laws of Pennsylvania, No. 1985-45, Section 5(b)(10) and 5(b)(14).
25. ibid., Section 6 (a)(1).
26. Section 333-200-080.

5.0 FUNDAMENTAL CONCERNS AFFECTING THE DEVELOPMENT AND OPERATIONS OF TRAUMA SYSTEMS

This section addresses two areas that have major impacts on the final design and operations of all trauma systems. The issues are crosscutting in nature - we saw their impact at every site we studied.

The first group of issues are economic considerations. The development of an adequate trauma care system, consisting of the components described in Chapter 4.0, is expensive. In order to meet the objectives of skilled intervention at both pre-hospital and hospital levels and rapid transport to ensure access to appropriate surgical care, trained staff and adequate equipment throughout the components are required. Few locations exist that are not struggling with economic constraints. At four of the sites we studied, economic conditions are seriously affecting the development of appropriate care. In the fifth, Eastern Pennsylvania, although some constraints are present, they are less of an impediment to development. In addition, that system's development has been assisted by contributions from a private charitable trust available to the trauma center hospital. Section 5.1 addresses economic considerations.

The second major area addressed in this section is that of institutional considerations. It is clear from the discussions in previous sections of this report that the development of a trauma system requires a significant level of commitment to make it successful and to overcome the natural barriers of economic constraints, competition among different components of the system, and the fact that for all of the system components trauma care is but one of many missions. Trauma care systems have often been built through the extraordinary commitment of one person or a small group. Although such commitment is admirable, our opinion is that it is impractical to depend on this fortunate but unpredictable occurrence. During our visits to the study sites, we particularly searched for the processes and approaches to system development and maintenance that seemed to promote the institutionalization of commitment and cooperation. Section 5.2 addresses the kinds of commitment and cooperation that have been required at the sites, and the various approaches used to promote that level of cooperation.

5.1 Economic Considerations

This section examines the costs of the trauma system, the methods used to finance the trauma system and the problems created by inadequate funding. In addition to the mere size of financial requirements, the issue of financing the system is made

more complicated by the fact that the system is made up of service components that are funded in various ways. The more fragmented the funding for care, the more difficult it is to direct, control and allocate appropriate resources to it. This patchwork of funding requires that on-going coordination and interorganization activity (planning, information flows, advocacy) take place to garner the resources needed to complete the system.

In addition to the financial issues faced by trauma system participants, this section also examines the economic concerns raised by non-participating hospitals and how these concerns have been addressed at each of the four sites (not including Oregon). These concerns are often a factor that impedes the development of trauma systems, through hospitals' unwillingness to support what appears to be a financial threat to their own well-being.

5.1.1 Funding of Prehospital Care

There are numerous sources of funding for emergency medical services, including support from local and county taxes, State legislative appropriations, Federal sources and third party reimbursements for direct services. All of these sources of funding are relatively unstable; they tend to fluctuate with the economic conditions of the area and are in competition with other demands on the tax base. For example, in the rural areas of Oregon and Texas not only have recent economic conditions been poor, but also changes in Medicare funding for hospitals have affected the health care system financially. Consequently, EMS care is in competition with other health care providers for adequate funding in the rural areas.

Table 5-1 shows the various sources of funding for the prehospital care at the five study sites. Emergency medical services are provided through both public and private sources, although at our five sites public sources have been responsible for far more than private.

Emergency medical services frequently are a component of the Fire Department. Funding is provided through the municipality or county tax base and the allocation is split between the medical service and the fire fighting responsibilities. Sometimes staffing is shared between the two as well, as was the case in a suburb of Sacramento we visited and in one of the towns near Bend, Oregon. In Allentown, Pennsylvania, and Dade County, Florida, the staff are dedicated to medical services but are housed in the Fire Department space. In addition to paid staff, much of the staffing for emergency medical services is provided through volunteers. For example, in the Texas Panhandle region, although services covering the city of Amarillo are staffed with paid paramedics, many

Table 5-1

Funding Sources for PreHospital Care

	<u>Dade County, FL</u>	<u>Sacramento, CA</u>	<u>Allentown, PA</u>	<u>Amarillo, TX</u>	<u>Bend, OR</u>
EMS:					
Staff	County taxes Private company staff Third party revenues	Municipal taxes Private companies staff Third party staff revenues	Municipal taxes Volunteers	Local taxes Volunteers	Local taxes Volunteers
Equipment	County taxes	Local taxes	State funds Local taxes	County taxes	County taxes
Training	County taxes	Hospitals	Hospitals State funds tuitions	State funds local taxes	Community College
Communications	County taxes	Municipal taxes	Charitable funds State funds and towns	Federal funds Charges to towns and counties Subsidy from NWTB	Local taxes
Helicopter	County taxes	Local taxes Hospital	Lehigh Valley Hospital Center	-none-	Sponsoring hospitals Subscriptions from ranch families
Regional Medical Director	Trauma center	Local taxes	Local taxes Charitable fund	Hospital contract	Free service from physicians

of the outlying, sparsely populated areas are staffed by volunteers. Some towns simply cannot afford paid staffing for emergency care; in other locations, the sparse population (and thus relatively low incidence of emergency situations) makes paid staff impractical. A compromise made in some areas is the provision of paid management to support a volunteer staff. Although it might be expected that volunteer staff would likely be less skilled than paid, we were surprised to find that 75% of the EMS volunteers in the Texas Panhandle were trained in Advanced Life Support techniques.

Adequate trauma care at the prehospital level depends on appropriate skills of the emergency medical services staff. Again, the skill level of EMS providers to some extent is related to the level of salary for paid staff. We often heard about staff who took paramedic training courses and then moved to cities and towns that could offer competitive salaries. State funds are frequently the source of support for training courses. In addition, in some locations, training courses are offered under the auspices of hospitals that are active and interested in emergency medical care. In other locations, EMS staff (both volunteer and paid) paid tuition for courses. In rural areas, such as the Panhandle, volunteers not only paid tuition, but also were not reimbursed for the travel costs associated with training courses. (Because training courses require a critical mass of students, some volunteers from outlying areas drove as much as two or three hours to attend evening courses.)

It is our impression, from studies of the five sites, that the Advanced Trauma Life Support course, which provides training to EMS staff in clinical intervention in trauma cases, is not as available or accessible as it might be. This is due to some degree to the current skill level of local emergency medical staff, many of whom have only achieved Basic Life Support Training (see Table 4-1) and thus do not have the prerequisite knowledge. In addition, however, it appeared that training budgets were constrained, and courses were chosen to address the most general pressing needs. Also there was some evidence that ATLS courses were undertaken on a voluntary basis, and not required even for paid staff. Among the five study sites, no state regulations governing EMS systems require ATLS training.

The cost of adequate EMS equipment can be prohibitive for poorer areas as well. (For example, an Advanced Life Support vehicle can cost \$40,000). In Pennsylvania, some equipment is purchased through support by state funds; the priority in that state is to ensure availability of basic equipment for the rural areas that could not support purchases through the tax base. Funding for advanced life support vehicles will have to wait until the basic needs are met. In rural Oregon, with sparse populations and

limited tax bases, one small town had only an old station wagon to serve as the ambulance. On the other hand, in Amarillo the EMS agency is subsidized by contributions from the city's three large hospitals. In addition, salary costs for the highly trained EMS staff are paid by the county hospital.

Beside public funding, the EMS agencies seek third party reimbursement for their services. Third party recovery meets their costs in varying degrees, depending on the insurance coverage of the residents. The fees charged to third party payors are not related to the actual cost of the service (for example, medical interventions or extrication time for motor vehicle crashes.) Rather, the service is paid a flat rate for a "call," plus mileage. It was reported that many public agencies will not charge the users for community relations reasons; most local residents consider the service to be paid for through their tax payments.

Another factor relevant to the development of an adequate trauma care system is availability of a medical director for prehospital services. The four sites with regional EMS agencies have designated Medical Directors. The amounts of time available from the Directors varied significantly and were probably related to the capacity of the agency to pay for the service. The Allentown system appears to have the most extensive Medical Direction; in that system the trauma center hospital provides salary and overhead support. In Bend, Oregon, where no regional EMS system exists, the St. Charles Hospital medical staff provides free medical review and quality assurance for the county-funded EMS agency. In Amarillo, the Director of the AERC of Northwest Texas Hospital provides medical direction to the regional EMS agency (recently purchased by the hospital).

Two other critical prehospital care components of the trauma system are adequate communications and rapid transport helicopter services. Four of the study sites have helicopter services; Amarillo, which needs rapid transport desperately, cannot afford the service. Helicopter service is expensive, costing upwards of \$1 million annually for rental, staffing and operation. Financial feasibility for helicopter service is related to volume of service and the potential for third party reimbursement.

In rural areas, where even with helicopter service maintaining the "golden hour" is extremely difficult, meeting either of these conditions is problematic. In sparsely populated areas, volume and insured population are just not there. In Bend, Oregon, the helicopter service was attempting to become self-sufficient through subscription arrangements with all the local hospitals and with individual ranch families in the outlying districts. The service had an operating loss of \$100,000 in its most recent

year of operation. Fortunately the service was underwritten by St. Charles Hospital, a rural referral center that is not experiencing the financial difficulties that many rural hospitals are. In Amarillo, Texas, where a helicopter service is the logical answer to the problems of distance, we were told that the service simply cannot be afforded.

A second system component that is critical in rural areas but is also vulnerable financially is the regionalized communication system that facilitates medical control of care as well as rapid dispatch of appropriate services. PEMSS of Amarillo has developed a high-quality communication system that covers 25,000 square miles of sparsely populated ranch and farmland. Operating costs are somewhat offset through charges to local towns for each unit of service; however, these revenues are not sufficient to break-even. The capital equipment that is the base of the system was purchased with Federal funds some years ago; it will require replacement, but there are no funds currently. In Bend, Oregon, where a regional plan for trauma care is under way, a communications plan is critical to overcome the "dead spots" of the mountainous area of farm and ranchland that prevent medical control of both ground and air service. The local tax bases could not afford the investment; and the Area Trauma Advisory Board was seeking charitable funds to support the purchase. Even in Allentown, Penn., an urban/suburban area, where we found well-developed prehospital and hospital care for trauma patients, the cost for communication equipment was subsidized by a local private charitable fund.

The fragmentation of funding described in this section can easily result in extremely uneven development of system components. To overcome this impediment, a strong planning approach is needed that identifies priorities and structures resource allocation.

5.1.2 Economic Issues in Hospital Care

Economic issues are involved in all aspects of hospitals' roles in trauma system development and maintenance. The development of trauma care capacity requires an extensive investment, primarily in professional staffing. The level of investment required varies, depending on geographic location and on the teaching status of the particular hospital. In order to maintain the service, most hospitals expect some sort of positive financial return; this can take the form of a "profitable" trauma service where direct revenues exceed costs, or some other indirect gain, such as good community relations or growth in other aspects of the hospital's services. The issues involved in both costs and revenues are discussed in the following sections.

In order to understand better certain aspects of these financial issues, we requested two types of financial information from the four trauma centers participating in our study. We asked for some brief financial information regarding the costs of providing trauma care through the hospital. And, we asked that each hospital provide payment information on a small random sample of trauma patients who had received inpatient care. Information from this small sample can be generalized to assess whether direct patient-related revenues are an incentive to provision of trauma care at this hospital. All four hospitals agreed to provide these data.¹ It should be noted that the cost information we received is useful only as the roughest of estimates; a true cost study would require more time and resources than we had available and was beyond the scope of this contract.

Cost Issues in Development and Operation of a Trauma Service. All of the physicians we interviewed in the conduct of this study support the standards developed by the American College of Surgeons (ACS) to ensure optimal care of the trauma patient. The ACS standards have also been adopted and included in the regulations governing trauma center development by most states that have such regulations. Of the sites we studied, Allentown, Sacramento and Dade County use the ACS standards. The Amarillo hospital, Northwest Texas Hospital, has recently adopted a different model of care, based on the use of Board-certified emergency room physicians supported by a call-roster of surgeons. Three of the hospitals meet Level I standards, the most stringent; up until recently, Northwest Texas Hospital met Level II standards.

The major costs arising from meeting ACS standards are physician staffing requirements. For both Level I and II trauma centers, in-house 24-hour coverage is essential in the skill areas of general surgery, neurosurgery, emergency medicine and anesthesiology. Additional, comprehensive surgical specialists are to be on-call and promptly available from inside or outside the hospital. ("Promptly available" was defined as within 5 to 15 minutes, with the capacity to be available when the patient arrives in the Emergency Department.)

Major teaching hospitals, with surgical training programs, have the easiest time in meeting the ACS guidelines. Three of our four study sites had extensive surgical training programs. In both Dade County and Sacramento, only the university affiliated, and publicly funded, hospitals were interested in providing trauma care because of the extensive level of required staffing (as well as uncompensated care). Teaching facilities can use experienced residents, who provide in-house coverage as part of their residency training programs, to meet ACS requirements. In addition, these types of facilities also

use salary arrangements for senior staff, who are thus compensated even if their patients are uninsured or underinsured. Furthermore, these facilities attract physician staff who seem to have particular interest in "trauma system" development.

Table 5-2 shows the information provided by the four trauma system sites. Two sites provided annual costs of 24-hour surgical coverage to the hospitals, estimated to be about \$500,000. In both these cases, residents provide a sizable amount of care, and are not paid above their standard salary for trauma service. In Amarillo, where an Emergency Physician model is being used, the annual cost to the hospital for 24-hour coverage of the Emergency Department by Board-certified physicians is about \$300,000. In addition to salaries and contracts, physicians providing trauma care are also able to collect fees for services in trauma care.

In addition to in-house coverage, the ACS guidelines require extensive on-call coverage by other surgical specialties. This is another area where costs to the hospital can be astronomical, depending on location and the accepted practice of the local medical community. In Allentown, there is a tradition by the local medical community to provide "on call" coverage to the hospital. The same was true in Bend, Oregon, where physicians are expected to provide on-call coverage until they reach age 65. In Sacramento, however, it was reported that only at the university hospital were physicians expected to provide on-call coverage without any payment in addition to the fees that would be generated from actual surgical services provided. In Amarillo, a call roster existed, but problems of attracting surgeons to provide on-call coverage arose, after the original surgical trauma team model was discontinued.

Although physician costs are extensive, there are other costs associated with trauma care. Two hospitals estimate that it costs between \$200,000 - \$250,000 in personnel costs to maintain a 24-hour operating room, dedicated to trauma care. Other hospitals use operating rooms that are not dedicated to trauma care, although the services are available round the clock. Three of our sites indicated that they had more extensive staffing in the emergency department, intensive care units and radiology department because of the trauma services.

In three of the study sites, trauma care patients are integrated with other patients in Intensive Care and Medical-Surgical units throughout the hospitals. Lehigh Valley Hospital Center has a separate Shock Trauma Unit that provides intensive and acute care and that is estimated to cost \$2.1 million annually.

Of our study sites only Lehigh Valley Hospital Center was able to estimate the total annual operating costs of its trauma care. Including its helicopter service, a dedi-

Table 5-2

Costs for Trauma Care at Four Sites

	<u>Dade Co., FL</u>	<u>Sacramento, CA</u>	<u>Allentown, PA</u>	<u>Amarillo, TX</u>
1. 24-hour in-house coverage:				
Staffing:	Salary for staff & residents	Salary for staff & residents	Contract for staff and salary for residents	Contract for staff. No in-house surgery
Costs:	\$530,000 includes residents' salaries	Unknown	\$440,000 plus resident salaries	\$300,000 for Emergency Room physicians
2. Arrangements for other surgical/medical specialists	Surgical residents	Residents and on-call	On-call schedules	On-call roster
Costs:	----- No additional costs to hospital -----			
3. Additional staff needed in ER to serve trauma care?	Nursing, unspecified amount	1 FTE nurse	5 FTE nurses	No, but up-graded staff (Residents, rather than RNs)
Costs:	Unknown	\$35,000	\$167,000	N.A.
4. Cost for two-way radio for EMS	Unknown	\$68,000	\$38,000	Part of total regional communication system (\$350,000)
5. More staff on ICU for trauma patients?	Yes	Up to 20 hours a day of RN time	Have special 12-bed Trauma Unit	No, but higher trained staff
Cost:	Unknown	est. \$100,000	\$2.1 million	Unknown
6. More radiologic capacity required for trauma care?	Yes	Yes	No	Yes
Cost:	Unknown	est. \$20,000	--	Unknown

Table 5-2
(continued)

	<u>Dade Co., FL</u>	<u>Sacramento, CA</u>	<u>Allentown, PA</u>	<u>Amarillo, TX</u>
7. 24-hour operating room dedicated to trauma?	No	Yes	Yes	No
Cost:	-	\$200,000	\$250,000	
8. Total Costs for Trauma	- Unknown	Unknown	\$2.6 million*	Unknown

* Does not include additional \$900,000 for helicopter cost

cated operating room, an in-patient unit, special trauma staff such as the trauma registrar and trauma nurse coordinator, and trauma team physicians, the annual operating cost was estimated as \$3.5 million.

The information presented in this section addresses only the most obvious of the direct costs associated with development of a trauma center. There are many indirect costs as well; these were evident at the study sites, but are not possible to quantify. To some extent, these are some of the resources that are embraced within the term "commitment" that is often used (for example, by ACS) as a crucial criterion for success of a trauma system. In fact, the concept of "commitment" is so broadly known that the Pennsylvania Trauma Foundation has included it among its standards for accreditation of a trauma centers. These indirect costs of trauma care include the time and efforts extended by hospital staff to maintain the capacity to provide service, such as the maintenance of reliable on-call schedules, and to promote adequate continuity of care as patients move within the hospital's units and are discharged.

Revenues from Trauma Care. The study also addressed the question to what extent there are financial incentives that promote the development of hospital trauma services. As was noted earlier, the benefits to the hospital that provides trauma care can be of varying kinds. The most direct benefit, and the most obvious, is the "profitability" of the trauma service.

Other benefits are less obvious, but have received attention within the hospital industry. One opinion is that the free media attention received by a trauma center can be valued and weighed against the investment costs of the trauma service. Another is that there are certain gains in prestige that enable hospitals to attract professional staff and to gain a reputation for critical care expertise that carries over into growth in other specialty services. Belief in these non-direct benefits has had a negative impact in some geographic locations, where hospitals with no interest in developing a trauma care capacity may obstruct trauma legislation or community action because they fear that non-trauma center hospitals will be financially harmed. The issue of the direct profitability of trauma care is addressed in this section. The issue of indirect benefits is discussed in Section 5.1.3, which also summarizes the results of a cost study conducted as part of this contract.

Payor Mix. The "profitability" of the trauma service is most directly determined by the payments made for the care of the patients seen on the service. The rates paid by some third-party payors, such as Blue Cross and the private commercial insurers, are at, or very close to, the prices determined by the hospitals. With the

introduction of the DRG prospective payment methodology, Medicare payments are calculated based on regional and national average costs of treatment for particular diagnoses and other factors, and consequently payment may be more or less than the hospital's expenditures to treat a specific individual. State governments determine the rates at which payments will be made for care of Medicaid-eligible individuals. County governments determine the rates paid for individuals who are eligible for "indigent care" funding; generally these are people who are uninsured, unemployed, and ineligible for Medicaid. The rates paid by state and county governments vary among states, depending on the states' economic conditions and the priority given the issue, but are often significantly below rates paid by Blue Cross and commercial insurance.

As part of this study, we collected payment information from the four sites. Three provided payment information based on a small (50 patient) random sample of trauma patients. Dade County provided payment information based on the hospital charges to trauma patients treated in five of the seven trauma centers and those treated by Jackson Memorial Hospital over a six month period. For the patient-level information, we collected the following data: the total hospital charges for the patient's stay, the payment source, the amounts paid and amounts uncollected. The samples were drawn from patients admitted four to six months prior to the time of our data collection, to allow maximum time for collection of the hospital bills.

The data in Table 5-3 show the extent to which the four sites collected payments for the trauma care provided to the patient samples. Lehigh Valley Hospital Center had collected 96% of the total charges; Northwest Texas Hospital had collected 73%; and UC Davis had collected 54%. In Dade County, five trauma centers collected 56% of charges while Jackson Memorial collected only 27% of charges. Because hospital charges are calculated in complicated ways, it is not possible to specify the extent of profits or losses from these figures. It is possible to infer, however, that both UC Davis and Jackson Memorial do not recover the costs of trauma care from their patient revenues.

Table 5-4 shows the payor mix of the small random sample of patients at Sacramento, Allentown, and Amarillo. As can be seen, the percentage of charges collected shown in Table 5-3 is related to extent of private insurance coverage (commercial and Blue Cross). At Lehigh Valley Hospital Center, 66% of trauma patients had private insurance, while 28% of trauma patients were eligible for Medicaid or were responsible for their own hospital care, two groups that frequently pay less than billed charges for care. In Amarillo, close to half the trauma patients (40%) were in these

Table 5-3

Amount of Charges Collected at the Four Sites
for a Sample of Trauma Patients

<u>HOSPITAL</u>	<u>TOTAL TRAUMA CHARGES</u>	<u>TOTAL PAID</u>	<u>PERCENT COLLECTED</u>	<u>PERCENT FREE CARE OR UNCOLLECTIBLE</u>
ALLENTOWN (LEHIGH VALLEY HOSPITAL CENTER)	\$700,468	\$674,483	96	4
AMARILLO (NORTHWEST TEXAS HOSPITAL)	\$400,469	\$292,700	73	27
DADE COUNTY A. JACKSON MEMORIAL HOSPITAL	\$6,674,622	\$2,442,818	27	73
B. FIVE TRAUMA CENTERS	\$18,393,542	\$8,016,999	56	44
SACRAMENTO** (UCD/MD)	\$1,020,337	\$550,274	54	46

* TOTAL TRAUMA CHARGES FOR ALLENTOWN, AMARILLO AND SACRAMENTO ARE THOSE OF A 50 PATIENT RANDOM SAMPLE. DADE COUNTY PROVIDED INFORMATION BASED ON THE CHARGES ASSOCIATED WITH THE TOTAL NUMBER OF TRAUMA PATIENTS TREATED IN A SIX MONTH PERIOD AT BOTH JACKSON MEMORIAL AND FIVE OF THE SEVEN TRAUMA CENTERS.

** THE CALIFORNIA FIGURES ARE BASED ON BOTH ACTUAL AND EXPECTED REIMBURSEMENT. ESTIMATES BASED ON VARIOUS CONTRACTUAL AGREEMENTS AND HISTORICAL EXPERIENCE.

Table 5-4

Payor Mix of the Patient Sample at Three Sites

<u>Site:</u>	Sacramento (UC Davis MC)		Allentown (Lehigh Valley HC)		Texas (Northwest Texas Hospital)	
<u>Payment Source</u>	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>
Blue Cross	2	4	7	14	2	4
Commercial	12	24	24	48	21	42
Workers Compensation	1	2	2	4	-	-
Medicare	2	4	3	6	4	8
Self-Pay	7	14	5	10	13	26
Medicaid	14	28	9	18	3	6
County Indigent Care	10	20	-	-	6	12
Other	<u>2</u> 50	<u>4</u> 100%	<u>-</u> 50	<u>-</u> 100%	<u>1</u> 50	<u>2</u> 100%

Source: Patient payment information provided by hospital administrators.

vulnerable groups, and 46% were covered by private insurance. UC Davis Medical Center has the least financially advantageous case mix of the three: 66% of trauma patients were covered by MediCal, county Medically Indigent funds or were listed as self-payors. The data on uncompensated care provided by Jackson Memorial Hospital indicate that many patients lack both insurance coverage and the ability to pay for care.

We looked more closely at the reasons for the levels of uncollectible payments at the sites where some detailed information was available. In regards to Medicaid payments, we found that there was a strong contrast between the proportion of hospital charges paid in Pennsylvania and that paid in California. Data provided by Lehigh Valley Hospital Center indicate that the eight trauma patients eligible for Medicaid were billed \$119,239; and all but \$670 was paid--an overall collection rate of 99.5%. On the other hand, in California, only 27% of the total charges of \$394,184 that were billed for the fourteen Medicaid-eligible trauma patients was estimated to be collected.

Another category where collection was extremely poor in California was the county-funded "Medically Indigent"; the hospital estimated that 21% of the amount charged would be collected. In Amarillo, the data provided by the hospital indicated that collections for individuals eligible for county Indigent Care or Medicaid are close to billed charges. The hospital, as a county facility, bills the county directly for patient-related care. In Amarillo, the uninsured accounted for the largest proportion of "free care." This situation was generally in contrast with Pennsylvania and California, where uninsured individuals appeared to have paid 87% and more of the billed charges. It is likely that varying eligibility requirements among the states for Medicaid and Medically Indigent funding account for these differences. In some geographic areas, stringent eligibility requirements mean that individuals without financial resources are left with the burden of hospital payment. In other areas, those who are "self-pay" may be ranchers or farmers without third party coverage, but who have the resources to pay for care. The rates at which state and local governments reimburse for medical care for individuals without financial resources is a matter that reflects the state's policy towards support of hospital services in general.

5.1.3 Financial Disincentives for Hospital Participation

Uncompensated or "Free" Care. The lack of payment for treating the underinsured and uninsured trauma patient is a major disincentive for the development of hospital services for trauma care. A high volume of these populations threatens the financial security of a hospital. This is becoming even more serious as the methods for

paying for health care change. Up until recently, under cost-based and charge-based payment methods, health institutions were able to subsidize unprofitable services through the more "profitable" ones. However, new payment practices that emphasize cost control and cost containment hamper this cross-subsidization. Third-party insurers or managed care organizations are interested in negotiating the lowest possible cost for their services and hospitals find themselves competing with each other to offer lower cost care. Consequently, "unprofitable" services are now less tolerated by hospital administrations than previously.

It is clear from the patient-level information discussed in the preceding section that there is currently little direct financial incentive to develop trauma services for hospitals located in geographic areas suffering from poor economic conditions. In fact, in our study, the three sites that are located in these environments are all public hospitals, and therefore are funded through county subsidies as well as through patient payments.²

The experiences in developing a trauma care system in Dade County have been fairly well publicized. Seven hospitals sought state verification as trauma centers. However, only Jackson Memorial Hospital as the county public hospital receives a subsidy. The annual subsidy is almost \$90 million for the total hospital services. But other hospitals in the trauma system also experienced high rates of uncompensated care in trauma services and these operational deficits were not offset by County subsidies. The president of Mount Sinai Medical Center revealed in a recent article in a health care journal³ that 55% of patients treated in that hospital's trauma center were indigent. Another trauma center in Dade County, Parkway Regional Medical Center, lost \$3.3 million in one year's experience as a trauma center. The same article reports that the continuation of the trauma system in Los Angeles is threatened for similar reasons.

Medicare Payment. Another financial issue that has received some attention is concern about the payment amounts for trauma care under the newly instituted Medicare prospective payment system. In our study of trauma patients, Medicare recipients accounted for only from four to eight percent of patients at the three study sites, and collection of hospital charges was close to 100%. However, a recent study from the University of Miami School of Medicine⁴ found that, if optimal DRG rates were calculated for 44 trauma patients who had required surgery, the payment for care would total only 30.9 per cent of actual hospital costs. A similar argument was made by Dr. Lenworth Jacobs⁵ who reported that the DRG methodology results in underpayment for serious trauma care to Medicare beneficiaries.

Research into the true financial equity of Medicare payment is critical. Although Medicare patients represent only a small proportion of trauma patients, the DRG methodology is popular as a model for other payors' approaches to prospective payment and is therefore likely to be adopted for use in payment for services of a broader population.⁶

Caseload Requirements. Another aspect to be considered in examination of financial incentives for hospital participation in trauma systems is that of the role of caseload requirements. The American College of Surgeons has adopted a caseload requirement in its standards. It estimates that a surgeon needs to perform about fifty surgeries annually in order to maintain surgical skills. From this estimate it has developed caseload guidelines for Level I and II trauma centers of 600 and 350 major trauma cases annually. A similar requirement related to volume seems reasonable in order to address the financial problems that exist when costs exceed payments. As was pointed out in Section 5.1.2, there are extensive fixed costs (primarily of salaries, but also some equipment) in hospital trauma care. Direct payments, and indirect subsidies, balance these costs. Consequently, the higher the volume of patients with some sort of payment, the more direct revenue is generated to offset the cost of the services.

For example, in our study of Northwest Texas Hospital which has a virtual monopoly on emergency and trauma care, the hospital administrator attributed the hospital's high occupancy rate (more than 85%) to admissions from the Emergency Department. The two other Amarillo hospitals were only half full. The NWTN administrator reported that he accepted the bad debt component of trauma care, because other patients, even the underinsured, defray some of his fixed costs.

Without a caseload requirement in a geographic area, there may be too many hospitals competing for too few patients. This could result not only in increases in hospital charges for trauma care but also in financial losses for many hospitals, with elimination of the service as a final result.

5.1.4 Indirect Effects on Participating and Non-Participating Hospitals

Many of our respondents for the study indicated their belief that participation as a trauma center results in definite "indirect" benefits to the hospital. This opinion underlay the concerns of the Sacramento hospitals that seek to prevent designation of a second trauma center in that area. The indirect benefits attributed to trauma center participation arise from the extensive free publicity available through newsmedia coverage of incidents that result in patients' care at the trauma center. In this way,

hospitals gain reputations as providers of high quality critical care. This reputation attracts both medical staff and consumers, thus giving the hospital a competitive edge over neighboring facilities.

Interestingly, little research has been made public regarding this question. A study in Orange County, California, indicated that trauma center designation did not result in increases in Emergency Department volume over a one-year period.⁷ Proponents of the theory suggest that such utilization trends need to be studied over a longer time period. Under this contract, AAI conducted a statistical analysis comparing designated trauma centers to other general hospitals across a number of variables that indicate size and extent of critical care and other activity. The study is included in Appendix D of this report. Results of the study indicated that although hospitals that are designated trauma centers appear to show increased utilization and activity in the first year after designation, those effects diminish in succeeding years. Again, the time period included in the study was short, covering at most four years, and this may have affected the findings. On the other hand, meaningful designation is a relatively new procedure in most states and no longitudinal data exist.

There are other opinions regarding this issue. One respondent thinks that there are visible competitive successes among designated centers; but this success is due to the fact that these particular hospitals are well-managed and innovative and would select endeavors at which they would succeed. Another theory is that development of a trauma service is relatively simple for a hospital. Investment is primarily in labor, rather than equipment, and no marketing is needed to attract users. If the service is unprofitable it can be relatively easy to discontinue.

Information from the four study sites does not confirm or deny the theory of extensive indirect benefits. Three sites are public county hospitals, and are therefore set apart from private hospitals in the geographic areas. The only private facility in our group, Lehigh Valley Hospital Center in Allentown, is clearly a dynamic, successful institution, appearing to be the center of health services for the region. However, it is hard to attribute its success to trauma care; many other factors are also operating there.

This is another important question to resolve. The current acceptance that trauma center designation is a financial bonanza has negative consequences in terms of trauma system development. Hospitals may be motivated to participate in trauma systems in order to achieve these indirect benefits, rather than being motivated by interest and community spirit. Other hospitals may be motivated to obstruct system development because of the competitive threat.

Economic Concerns of Non-participating Hospitals. At four of our study sites respondents reported events and issues that indicate concerns that somehow the development of an adequate trauma system will result in losses to non-participating hospitals and medical staff. The professionals and institutions anticipated losses in prestige and in capacity and skills, as well as in market share.

A description of events and issues related to these concerns at four sites, in California, Texas, Pennsylvania, and Oregon, follows. Oregon is included because we studied that site during the state's trauma system planning process, and the concerns about anticipated losses were part of the debate. The descriptions below indicate how the concerns about anticipated losses have been raised and how the planners and implementers of the system have addressed these concerns.

California: In Sacramento, the local EMS agency, operating as the arm of the County Health Department, led the effort in 1984 to establish an "interim" trauma system. The planning phase included representation from community hospitals, emergency medical services agencies, the health professions, and local public officials. Although some interest was expressed by private hospitals, at the end of the planning phase only UC Davis Medical Center could meet the Task Force's criteria for selection. The criteria requiring 24 hours in-house surgical coverage and on-call participation by specialists could not be met by other hospitals. As noted in other sections of this report, physicians in Sacramento do not have to provide on-call coverage at Emergency Departments of their affiliated hospitals.

The resulting caseload has been too much for UC Davis⁸, and the area is seeking to designate a second trauma center at the other end of the country. At this prospective center it is estimated that the caseload would include far fewer uninsured and under-insured individuals than at UC Davis/MC; consequently there is a more positive financial outlook. Nevertheless, our respondents reported that there has been much difficulty in reaching agreement to seek and select a second trauma center. Although few local hospitals were interested (probably because of the problem of obtaining physician participation in the role) neither did they want any other hospital to participate. Their reaction to UC Davis being designated had been mild; but they reported that since UC Davis is the county funded hospital, it is not a threat to their desired markets anyway. Their concerns clearly were the effects of trauma designation on their own market share in the non-trauma areas.

To address this concern the local Hospital Association funded a consultant study to examine potential effects on market shares. The hospitals agreed to abide by the

results and support the designation action if the study indicated that the hospitals would not lose market share. The results of the study were not available at this writing; however, as of December, 1987, the EMS agency was still planning a second Request for Proposal for trauma center designation. During the exploratory process, no hospital expressed interest in being designated as a second trauma center. It can be assumed that whatever benefit any institution hoped to attain as the second trauma center hospital was not sufficient to attract the medical staff to participate. Furthermore, initial study results show a start-up cost of about \$1 million if a hospital permits itself to be designated a trauma center.

Pennsylvania: Lehigh Valley Hospital Center (LVHC) was the first trauma center designated by the state Health Department in 1981. Shortly afterward, the designation process was changed; LVHC was "accredited" by the Pennsylvania Trauma Foundation in 1986.

Development of LVHC as the regional trauma center began in 1979, when the regional EMS agency, Eastern Pennsylvania Emergency Medical Services Council, conducted a "categorization" activity with all the hospitals in the region. A process was designed to incorporate and respond to all of the concerns of the local hospital and medical industry. A representative from every hospital participated on the committee; and minutes were circulated to every hospital Chief Executive Officer and Chief of Medical Staff. The trauma categorization took place after categorization for all other specialties. The entire categorization effort took place using a consensus approach over a two year period.

A similar process was followed when LVHC decided to provide rapid transport helicopter service. The Hospital asked for the sponsorship of the EMS agency. Other hospitals in the area were concerned that the helicopter program would "steal" their patients and in response the EMS Board established 28 conditions for the agreement. One is a quarterly review of all helicopter patient records to identify "over-triage." It was reported that over-triage is less than eight percent.

These, and other efforts made by LVHC, are not sufficient to quell the competitive tensions among the regional hospitals, especially with the increasing financial pressures on hospitals. Some hospitals are concerned about "over-triage", insisting that it is imperative that their Emergency Departments see a range of patients in order to maintain the staff's skills in critical care treatment. Respondents reported to us that surrounding hospitals direct their local EMS agencies to bring all patients to them, regardless of medical conditions, even though there is a categorization agreement.

Without a by-pass and transfer regulation, the EMS staff are often reluctant to disagree with these approaches.

Texas: In 1972, Northwest Texas Hospital, the county public hospital, became the site for the Amarillo Emergency Receiving Center (AERC), when the three large hospitals in the city agreed to consolidate emergency services. A trauma team from out of state was hired to develop the hospital's trauma service.

During our site visit, our respondents reported that the AERC trauma concept never was really accepted by the medical community because of local physicians' concerns that the Trauma Service "stole" patients. With the departure of the Trauma Service's surgical staff, a new model of care, dependent on certified Emergency Department Physicians and a call roster of community surgeons has been established. As has been noted in other sections, it is too soon to know whether this new approach to trauma care will be successful.

Since the AERC was established, the financial pressures on Amarillo hospitals have increased sharply. During our site visit in July, 1987, it was reported that occupancy rates in the other two hospitals had dropped to about 50%, while Northwest Texas Hospital's occupancy rate was about 85%. The NWTH Administrator believes that the trauma service, and admissions from the Emergency Receiving Center, account for this good performance. Although the other two hospitals have continued to be supportive of AERC, it also appears that they are considering changes in terms of their cooperation. One facility has opened an Immediate Care Clinic, which competes during daytime hours with AERC. Both facilities have offered to purchase NWTH from the county.

The competitive tensions between the facilities are somewhat tempered by the fact that, as in California, the Amarillo physicians do not have a tradition of providing on-call services. Therefore, as one administrator noted, even though he might be interested in developing an Emergency Service, there are no physicians to staff it. Local physicians are on staff at all three hospitals, and it is their habit to refer patients who call them with emergency conditions to the AERC.

The Emergency Medical Services system of Amarillo has developed approaches to respond to the local medical community's concerns about potential loss of patients. The EMS staff follow "patient preference" procedures; they ask a conscious patient if he has a preference regarding physician. If the patient does, the EMS staff will communicate with the physician and will follow that person's direction in terms of disposition.

Oregon: The planning process for trauma system development was occurring at the time of our study visit in early 1987. St. Charles Medical Center, in Bend, was the logical choice as the facility for regional trauma care. It is already a designated rural referral center and is the largest hospital in the region. The concerns raised by the staff of smaller, local hospitals were related to the potential effects of a trauma care plan on them, if St. Charles were to be named. Neighboring hospitals were concerned that there would be over-triage; patients who could be treated locally would be taken via helicopter to the Medical Center, thereby causing a diminution of the skills available in the local hospital. The lack of patients would result in losses of needed medical staff. The design of a trauma care plan was seen as another threat to the existence of rural hospitals, that are already struggling with survival as a result of the Medicare prospective payment program and uncertain economic conditions in areas where the economy is dominated by agriculture.

Overall, it seems that non-trauma center hospitals' attitudes toward trauma centers and an integrated trauma system are subject to two contradictory influences: on the one hand, these hospitals would like to have the prestige and the patients that are purported to come to a trauma center because of its designation; on the other hand, many of these hospitals and their attending doctors are not willing to invest the resources, of money and of physicians' time, to provide the equipment and staff which a trauma center needs. Often, therefore, hospitals that are not part of the trauma system adopt a purely negative stance: while they themselves do not want to become trauma centers, neither do they want other hospitals to join the system and usurp what these hospitals perceive as "their" patients.

An attitude of "passive resistance" seems to govern the actions of many of these hospitals with regard to the establishment of a full trauma system. They endure the existence of a publicly-funded trauma center (because it treats the uninsured and indigent and is not seen as attractive to insured patients), but they do not support and even resist the expansion into a full-fledged trauma system. Jackson Memorial Hospital, UC Davis Medical Center, Northwest Texas Hospital receive most of the trauma in their region, more than they should and often more than they can comfortably handle. Many of the other hospitals in these regions seem willing to encourage over-triage to these trauma centers, if that means that no other trauma center will be set up, because that is perceived as threatening to the financial viability of the other hospitals. Perhaps, one publicly-funded trauma center is something that other hospitals can live with; but several trauma centers, organized into a system, are perceived as threatening.

5.2 Institutional Considerations: Cooperation and Commitment

There is no question that the success of the trauma system is dependent on a spirit of cooperation and commitment among the many parties who are involved in its maintenance. A productive level of cooperation is difficult to maintain amongst the stresses that have already been discussed. Anecdotal information available from our respondents and from other sources indicates that many successful trauma systems are the result of the extraordinary commitment and influence of one person or a small group. This is not a solution to the promotion of trauma care systems: there simply are not enough heroes to go around in the first place, and in the second, a major emphasis has to be system stability and continuity, which is frequently problematic in a hero's aftermath.

Consequently, we sought information at the five sites about institutional characteristics and procedures that made the systems successful.

1. Four sites had engaged in a formal planning process that resulted in establishment of a trauma system. In Sacramento, Allentown, and Amarillo, the EMS agency was the focal point for the planning process. In Oregon, which does not have emergency medical services legislation currently, the planning process was designed by the state Health Department and a state-level advisory board. In Dade County, no planning process took place.

The planning processes were inclusive of varying constituencies. All four sites invited representatives from all the parties of interest during the process, including the prehospital agencies, the hospitals, and the medical community. Decision-making during the planning process reflected the inclusive nature of representation and appeared to follow the model of consensus when that was feasible.

2. In the four sites, the planning process was followed by a mechanism for continuing coordination, although the success of this seems to have varied among the sites. In Allentown and Amarillo the EMS agency council has provided such a mechanism and the leaders of the trauma care system actively participate in the process. In California, although the mechanism exists, participation by all of the system components was reported to be less than full. For example, the Trauma Service Director of UC Davis did not participate in the EMS council's activities after designation, although there is representation from the hospital. This mechanism provides a continuing forum where questions and dissatisfactions can be raised. A willingness to respond to concerns and willingness to modify the system seem to be critical factors, because it allows issues to be resolved while they are still relatively fresh.

The system should have a feedback mechanism built into it, so that if there are real or perceived difficulties with any component of it, this can be noticed in a timely fashion and addressed, before the problem becomes unmanageable. Even a small problem, if it is not addressed, can fester and over time sabotage the needed cooperation.

3. The trauma center and particularly the trauma team and its trauma surgeon need to take a leadership role with regard to all of the parts of the system. A conscious effort at "team-building" must be made, so that all the human component parts of the trauma system perceive themselves as being part of a team.

If there is a team, dedicated to treating trauma patients, then such things as quality assurance will be easily taken care of. Each team member will take an interest in seeing to it that the quality of the care throughout the system--from prehospital care at the scene of the emergency to the patient's rehabilitation perhaps months after the initial injury--is appropriate.

Because the trauma system is large and complex, all its members must be part of the team: not only the trauma surgeon, but the trauma nurse and other nurses, the EMTs and/or paramedics, as well as the other physician specialists who may be involved. All team members must be encouraged to think of themselves as, and behave like, professionals with dedication to the successful outcome of trauma care.

4. An important set of institutional procedures that help make a trauma system function are written agreements and guidelines. Although it is neither possible nor desirable to completely eliminate human judgment in anything related to medical care, these judgments can be made easier and more likely to lead to success if written guidelines exist such as these:
 - a. transfer agreements among hospitals that indicate clearly when a patient should be transferred to a trauma center.
 - b. written triage criteria for the EMTs/paramedics to follow when dealing with a serious case of trauma.
 - c. contracts between the regional EMS agency and the trauma centers, spelling out the trauma center's responsibilities and duties. If there is a written contract that clearly states that the trauma center is the hospital to which a trauma patient should go, this places legal responsibilities on the trauma center as well as on physicians, EMTs, and other hospitals who may be tempted to treat a trauma patient themselves.
 - d. written criteria for trauma center designation or accreditation.

- e. written standards for the ambulance services for times of dispatch from receipt of call, for time to the scene, and time to the hospital.
 - f. written guidelines for quality assurance procedures, including what information is to be supplied to the trauma registry and by whom.
5. The ACS standards for trauma centers speak of commitment as being the most important ingredient in a successful trauma center. Similarly, in a successful trauma system there must be commitment on the part of physicians, hospitals, and prehospital care providers. Lest commitment be perceived as a nebulous term, it can be demonstrated by the following actions:
- on the part of physicians: by making themselves available for trauma care; by being on-call even at inconvenient hours; by treating patients regardless of ability to pay.
 - on the part of hospitals: by becoming trauma centers or by supporting those that want to become trauma centers and supporting the entire system.
 - on the part of prehospital care organizations: by providing advanced training for EMTs/paramedics, particularly ATLS courses and dealing with the tuition/travel issue especially for volunteers.

NOTES

1. The difficulty of producing the information we requested made it clear that hospital costs and payment information is ordinarily not organized to reflect these issues. We appreciate the efforts that all the sites made to respond to our request.
2. The poor payment potential of victims of innercity trauma (the "knife and gun club") is well known. However, it is interesting to note that even victims of motor vehicle trauma in Dade County have poor payment records; with 54% of hospital charges uncollected. This is in contrast to Allentown, where a strong state auto insurance law seems to ensure payment for care. This information raises further questions. It may be that Florida auto insurance laws are somewhat unprotective of motorists. Or, it may be that Jackson Memorial does not have an aggressive collection policy.
3. "Trauma centers struggling in L.A., Miami," Modern Healthcare, July 17, 1987.
4. Kreis, D., D. Augenstein et al. Diagnosis-related Groups and the Critically Injured. Department of Surgery, University of Miami School of Medicine, Miami, Florida (undated).
5. Jacobs, L. "The effect of prospective reimbursement on trauma patients," Bulletin of the American College of Surgeons, February 1985, pp. 17-22.
6. Senate Bill 10, introduced in the 100th Congress by Senators Cranston, Gore, and Kennedy included a provision to study the impacts on trauma care resulting from Medicare and Medicaid reimbursement policies.
7. Cales, R.H., P.G. Anderson, and R.W. Heilig, "Utilization of medical care in Orange County: The effect of implementation of a regional trauma system." Annals of Emergency Medicine, 1985, 14:853-858.
8. UC Davis' trauma caseload was estimated at 1,200 cases per year at the time of our site visit; six months later it was estimated to be in excess of 3,000 cases.

6.0 FINDINGS AND RECOMMENDATIONS

This chapter is divided into three sections: Section 6.1 details our findings (from the literature review and our site visits) and relates them to the first four objectives of this research (see Chapter 2). The fifth objective is to recommend strategies to NHTSA for promoting the development of trauma systems. These recommendations can be better understood in the light of Sections 6.2, which describes the optimum method for developing trauma systems; consequently they are presented in Section 6.3.

6.1 Findings

Each of the subsections below addresses the findings related to one of the research objectives listed in the RFP and in Chapter 2.

6.1.1 Existence of Complete Regionalized Trauma Systems

The first objective was to analyze the number of regionalized systems having true echelons of trauma care versus designation in name only.

We did not in fact find any complete regionalized trauma system, consisting of vertically integrated trauma centers of different levels, together with the other parts of a trauma system. We did find partial trauma systems and systems that provided good trauma care. Many of the "systems" that we saw were still in the process of being set up and efforts were still under way to add resources to the system and to find ways of making it work smoothly.

We did not expect to find a trauma system in Oregon, since the very reason we visited that state was that its sparse population makes establishment of a trauma system very difficult and Oregon is just beginning to address the problem of how to develop trauma centers and trauma systems. In the other four sites, however, we had hoped to find at least one or two complete systems.

The Texas Panhandle region could not be expected to have a true trauma system, either. There is no state designation or even verification of trauma centers. The American College of Surgeons reports that there is approximately one serious injury per 1000 population (per year).¹ Thus, the small population of the region (about 360,000) suggests that there would not be sufficient caseload for more than one Level II trauma center.

The 1985 Report on Sacramento Critical Trauma, produced for the Sierra-Sacramento Valley EMS Agency notes that the population of Sacramento County is about 800,000. This would suggest about 800 cases of severe trauma per year, well within the capabilities of a Level I trauma center. Two things must be noted, however: first, the UC Davis Medical Center has been designated as only a Level II trauma center. Thus it requires only 350 - 600 cases annually to maintain its standing and the skills of its surgeons. In actual fact, however, UDC/MC saw about 1,200 cases of trauma last year (and the most recent information, in December 1987, suggested that the trauma caseload was above 3,000. What this means is that the Medical Center receives not only serious trauma but all or almost all of the trauma in the county and perhaps the region). The 1985 report referred to above notes that 1,741 trauma victims were hospitalized in 1980. Using the incidence estimate of 1 serious injury per 1000, we conclude that not all were serious trauma patients; it would seem that over half of them did not require the attention of a Level I or Level II trauma center. In fact, in Sacramento County, UCD/MC feels that it receives too many trauma patients. Minor trauma is needlessly triaged to UCD/MC and prevents the medical center from fulfilling some of its other missions. If there were a second Level II trauma center, the case load of serious trauma could be split between UCD/MC and that second center and perhaps some of the minor trauma could also be siphoned off from UCD/MC. Here, then, is a case where there should be a second trauma center. But the hospital that is the most likely candidate for such designation resists, because it feels it cannot afford to staff up to ACS standards. The hospital in question, Mercy San Juan Hospital, was willing to apply for Level II designation, if the 24-hour availability of surgeon and neurosurgeon could be modified to "available within 20-30 minutes." The Board of Supervisors (the designating authority) was not willing, however, to compromise on the standards; consequently, Mercy San Juan withdrew its application.

Dade County's population on April 1, 1980 (the census date) was 1,626,000. The estimate for April 1, 1987 provided by the county Office of Planning, was 1,829,000. This suggests 1,800 cases of serious trauma per year. These numbers indicate that Dade County should have one Level I trauma center, and three Level II trauma centers. This is the number strictly from the caseload point of view. However, during our site visit we also heard that from a geographic point of view, Jackson Memorial Hospital (Level I) plus three Level IIs could cover the area: Baptist Hospital in the south, Parkland in the north, and Mt. Sinai in the east (Miami Beach).

This of course is not what we found. At one point there had been one Level I and six Level II hospitals -- clearly too many for the area. Now there is only one trauma center; namely, Jackson Memorial Hospital, the Level I trauma center -- clearly insufficient and putting a very large burden on this one hospital. This is looking at the situation only from the population point of view. It ignores other problems such as long transport times that are caused because every trauma patient has to be brought to Jackson Memorial Hospital, even from outlying areas. It also ignores the burden of uncompensated care that is solely borne by JMH (although that hospital does get county funds). It also ignores the problem that other hospitals may now be facing because their surgeons are not able to maintain their trauma-surgery skills since they do not see any trauma patients.

The population in the service area of the Eastern Pennsylvania EMS Council is about 1.3 million, suggesting about 1,300 severe cases of trauma each year. Even if the Level I trauma center (Lehigh Valley Medical Center) were to handle 1,000 of these cases, there would still be enough cases for a Level II trauma hospital. So far, however, no Level II trauma center has been designated in the area by the Pennsylvania Trauma Systems Foundation.

The absence of complete trauma systems in our sites is probably due in part to the fact that the concept of trauma systems is still new. Trauma centers are still very much in the process of being designated, so that it is too much to expect true and perfected systems to exist already.

In part, the absence is due to our site selection criteria. We did not want to visit extremely large metropolitan areas, because of constraints of resources and time. Still, in Sacramento, Allentown and Miami there should be two or three Level IIs in each area; some effort is being made in that direction in Sacramento and in Allentown. In Dade County, there appears to be no forward motion at this point.

6.1.2 Methods of Trauma System Implementation

The second objective was to analyze the methods in which trauma system were implemented, e.g., self-designation, regional designation, state designation, professional designation, and the method or methods which appear to sustain true systems of trauma care.

The method by which trauma centers are designated (see Section 2.3.1) was a major factor in our selection of sites. Thus, we visited:

- A state that verifies as trauma centers all hospitals that affirm in their application that they meet the ACS standards. This was Florida.

This method of trauma center designation first permitted the excess of trauma centers in Dade County and then could not avert the demise of the system when one after another the hospitals dropped out of the system as they encountered unforeseen financial burdens.

This approach to designation is based on a "free market" principle, which presumes that some number of hospitals will drop out as market conditions are played out. This method, however, provides no support or encouragement for the development of a stable delivery system. Allowing extensive excess capacity to be installed increases financial risk for all participating facilities, even without the high level of underinsured and uninsured users that is found in Dade County. At the same time, costs for trauma care are driven up for charge-paying users.

- A state with strong legislation and strong powers of designation. This was California.

Although the actual power of designation has been delegated to counties or multi-county regions, this state legislation provides a strong structure within which local decision-making can operate. The strengths of the legislation are its focus on trauma systems (not just the trauma center), the requirement for a written plan of action addressing critical systems issues, and the requirement for a contractual relationship between the county and the trauma center. Thus the legislation encourages the planning and systems maintenance activities described in Section 5.0. Designation carries with it definite obligations not only for the designated trauma center but also for the other components of the health care community. Health professionals are required to send a serious trauma patient to the designated trauma center (unless there are overriding medical reasons to stabilize the patient first elsewhere).

One potential result of this is overtriage; other health professionals may overcomply fearing the possibility of legal liability. In Sacramento, it appears that almost every trauma case, serious or not, goes to UCD/MC. Two factors seem to be behind this: the fear of liability as well as the fact that, because physicians do not have the tradition of providing on-call coverage, some hospitals may simply not have the medical resources needed for even non-serious trauma in the Emergency Department.

- A state that had delegated its designation authority to a private, non-profit organization. This was Pennsylvania, where trauma center designation is carried out by the Trauma Systems Foundation.

This legislation is relatively recent and so its effect on trauma system development is not yet clear. The establishment of the Pennsylvania Trauma Foundation has brought together in its Board of Directors all of the interested parties in the state. Thus an opportunity is afforded, at the state level, to address some of the major disincentives to trauma system development, such as policies regarding public payment levels and uncompensated care, and to approach systems development from a state perspective. One important result of participation of these interested and knowledgeable parties has been the establishment of very stringent standards for trauma center designation. However, as currently designed, the Foundation's approach addresses only accreditation of hospital applicants and does not review the potential trauma center in terms of its role within a trauma system. Consequently, the planning and maintenance activities that we found to be crucial to continued success at the community level are not supported or encouraged.

The legislation also includes a funding mechanism, based on a surcharge on moving motor vehicle violations. Most of the monies raised are allocated to service system development. However, we understand that these funds have been used to replace legislative appropriations for the development of emergency medical services. Consequently, funds are allocated to development of basic prehospital services, to meet the greatest needs, and not specifically to enhance the capacity of the prehospital systems to provide trauma care.

- A state that does not designate or verify trauma centers at all. This was Texas, where hoped-for legislation setting up designation authority failed to pass in the 1987 session of the legislature.

The lack of any state legislation leaves the development and maintenance of trauma systems completely to local community initiative. Although many good systems of care have no doubt been developed under these circumstances, the resulting systems appear to be much more vulnerable and unstable than systems developed in states where there is state-level governmental support and structure. The system in Amarillo is a good example of how much can be achieved through community goodwill and on-going attention to system maintenance. However, the new economic pressures on the health system are changing the environment in which the trauma system has worked successfully in the past. It is not yet clear whether the pressures on the other Amarillo

hospitals will affect the trauma care system. But it is clear that the trauma system is vulnerable. A second important point in terms of vulnerability to change is the newly instituted model of the on-call roster to provide all surgical intervention. Such a model may work superbly - or it may not. The absence of an outside instrumentality, such as state regulation or a contractual relationship with the county government, to permit or encourage "arm's length" review of the quality of care being rendered, makes it very difficult for the local community to address this issue.

- A state where many regions do not have the critical patient mass (i.e. case load) to have a designated trauma center. We chose Oregon for this, because -- aside from the Portland metropolitan area -- the state is sparsely populated.

Oregon appears to have been able to take the lessons learned in other areas into consideration in its development of an approach to trauma systems. This state's approach has included strong legislation, involvement of representatives of all interested parties at the state level, and the promotion of a local decision-making process at the community level. Consequently, representatives from rural areas not only influence development within their own region, but can influence the statewide policy and approach regarding transport regulations and triage criteria.

6.1.3 Impact of Trauma System Development on Prehospital EMS Structures and Costs

The third objective was to analyze the impact of trauma system development on prehospital EMS structures and costs. There is no doubt that a well-functioning trauma system and even the partial systems which we found in our sites raise the expectations placed on prehospital care and on EMS, EMTs and paramedics. They need to do more; they need to get patients to the right hospital rather than any hospital; they must do so quickly and decide between stabilizing the patient at the scene and rushing him to the hospital. These decisions are not always easy and guidelines are often contradictory:

With the exception of major trauma patients, the guiding principle of prehospital care is STABILIZATION OF THE PATIENT AT THE SCENE BEFORE THE TRANSPORT. The tendency to rush the critically ill patient to the hospital must be avoided. However, delay of patient care is also to be avoided.

(From the Eastern Pennsylvania
Emergency Medical Services Region
EMT Paramedic Protocol Manual, p. 3.)

This guideline leaves a great deal to the judgment of the EMT/paramedic. In an evaluation of the Sacramento County trauma system, an EMT/paramedic could read the following:

The averages reported by S-SV EMS appear to indicate excess time on the scene and excess time prior to starting advanced life support on the scene.

(From August 1986 Evaluation of Operations of the Sacramento County Interim Trauma System, p. 8.)

An immediate conclusion that can be drawn is that training of EMTs and paramedics must be upgraded to help them cope with such contradictory guidelines and that training has to be continuing. This puts a burden on EMS.

Additional resource requirements arising from a well-functioning trauma system are the need for well-functioning communication systems. Many of the EMS regions we visited have such systems; however, they are aging and some of them are not able to cope with peculiarities and difficulties of the terrain (for example, in Oregon).

The desired transport times may indicate air transport -- a very heavy burden on EMS and one which sometimes is shouldered by the taxpayers separately (as in Dade County); sometimes it is borne by the trauma center (as by Lehigh Valley Hospital Center and UC Davis/Medical Center). In eastern Oregon, a private not-for-profit organization is attempting to provide helicopter service; it is unclear at this writing whether it will succeed financially. In the Texas Panhandle, no helicopter is available, though it would be desirable.

Overall, the raised expectations put additional financial burdens on prehospital services and structures (see Section 5.1.1). It appeared to us, however, that EMS agencies in general welcomed these burdens. More than any other part of the trauma system, the EMS agencies and the EMTs/paramedics can see the benefits of trauma systems -- they have greater confidence that the patients whom they transport will live. As a result, they generally support whatever needs to be done to make this possible.

6.1.4 Financial Impact of a Trauma System on Hospitals

The fourth objective was to analyze the financial impact on primary care institutions, e.g., lost or gained revenues from patient flow patterns, insurance costs, equipment and personnel costs for designated centers, etc. Our findings here are

complex and are different for different kinds of hospitals. We begin by quoting the findings from the statistical analysis of approximately 6,000 hospitals that was conducted to discover if trauma designation had any effect on hospitals. (The study is included as Attachment III to this report.) The author, Dr. David Kidder, writes:

The findings suggest that hospitals that installed [trauma] units were larger, more costly and more likely to be teaching institutions than nontrauma hospitals. It was further suggested that, when the first year experience of trauma hospitals was viewed separately, many hypothesized effects often appeared to be realized: increased total inpatient and outpatient utilization, reduced outpatient surgery, increased staffing levels. But beyond the first year, hypothesized effects "decayed," and hospitals with trauma centers regressed back toward the average for their respective classes, in almost all outcomes measured. Because these longer run post-implementation measures are the best available as tests of the impact of establishing a trauma unit, the conclusion to this analysis must be that, for the most part, trauma units have had no identifiable tendency to change overall levels of utilization, costs and staffing in U.S. hospitals.

(Attachment III, p. III-17)

Looking now at the findings from the five site visits, we found the following:

Level I trauma centers. This includes Jackson Memorial Hospital in Miami and Lehigh Valley Hospital Center in Allentown. We also include University of California at Davis Medical Center which, although designated as a Level II center, can meet the Level I criteria and is, like the other two hospitals, a teaching hospital. Case study evidence supports what Dr. Kidder found statistically, namely, that teaching hospitals with and without trauma units are quite similar (op.cit., p. III-15). As large teaching hospitals, they can meet the staffing requirements of ACS through their residents. Lehigh Valley Hospital Center estimated the annual cost of providing trauma care at \$3.5 million. The other hospitals could provide no estimate of their costs. Insofar as there are any financial problems for these teaching hospitals, they seem to arise from uncompensated care. In Allentown, "free" care was not a problem; in Miami, the county helped fund "free" care; in Sacramento, the "free" care burden seems to arise more from payment policies of MediCal and the county than specifically from trauma.

Level II trauma centers. The only Level II trauma center in our group was UCD/MC and that is really a Level I, university-affiliated teaching hospital. It is clear from the information supplied, however, that Level II trauma centers suffer severe financial impacts. They are required, by ACS standards, to meet the same 24-hour availability of surgeons and neurosurgeons as Level I hospitals, without having residents to provide this coverage. Hence, in Dade County, all of the Level II hospitals dropped

out of the system. In eastern Pennsylvania, where caseload size suggests there is a place for a Level II hospital, no application for certification has been received. Similarly, in Sacramento, where a Level II hospital in the northern end of the county would help UCD/MC by reducing their caseload, a candidate hospital refused to apply for Level II status because of the rigid 24-hour staffing requirements. In Amarillo, Texas, Northwest Texas Hospital does not meet the staffing requirements for a Level II center, though it is the trauma receiving center; clearly no hospital in the Texas Panhandle could meet the staffing standards or would even be willing to try.

Other hospitals. If, as the statistical analysis suggest, there really is no long-range impact of trauma center designation (i.e. there is no increase in utilization and costs, with associated increases in revenues and staff), then other hospitals should not be concerned about their own financial well-being when trauma centers are designated. The statistical analysis only encompasses four years, so we cannot see a truly long-range effect, of course.

In any case, other hospitals clearly fear that trauma center designation will give a trauma center a competitive advantage and take patients away from non-trauma center hospitals. To mollify these hospitals, in both the Allentown area and the Sacramento area, helicopter transports are carefully reviewed by committees including representatives of these other hospitals to make sure that helicopter patients were properly triaged to the trauma center. (Helicopters are the most visible way in which trauma centers appear to be taking patients away who, if transported by ground ambulance, might have gone to a different hospital.)

These "other" hospitals do not themselves want to become Level II trauma centers because they correctly perceive that this would be costly to them. (We have no evidence on whether Level III designation would be desired or feasible.) At the same time, these "other" hospitals fear a Level II hospital from a competitive point of view and do not wish this designation to be conferred on a competing hospital. Thus they arrive at what we have called a double negative attitude: they do not want to be Level II trauma centers, but neither do they want other hospitals to be so designated. This obviously is an undesirable attitude from the point of view of developing full trauma systems.

6.2 The Optimal Method for Development of a Trauma System

The review of what exists in the five sites visited and of what impedes fuller development of these systems indicated that there are three major and three minor factors that are involved in the development of a trauma system of care. The optimum method for development of a trauma system is one that strengthens each and every one of these factors so that they can function harmoniously together.

The three factors are:

- Legislative action
- Assumption of a leadership role by the EMS region, involving
 - Local level involvement in decision-making
 - Support of physicians
 - Support of hospitals and hospital administrators
- Support by state and federal agencies through funding, particularly of uncompensated care

These factors are shown in Figure 6-1. They surround and influence the Trauma System of Care, which is shown inside the box.²

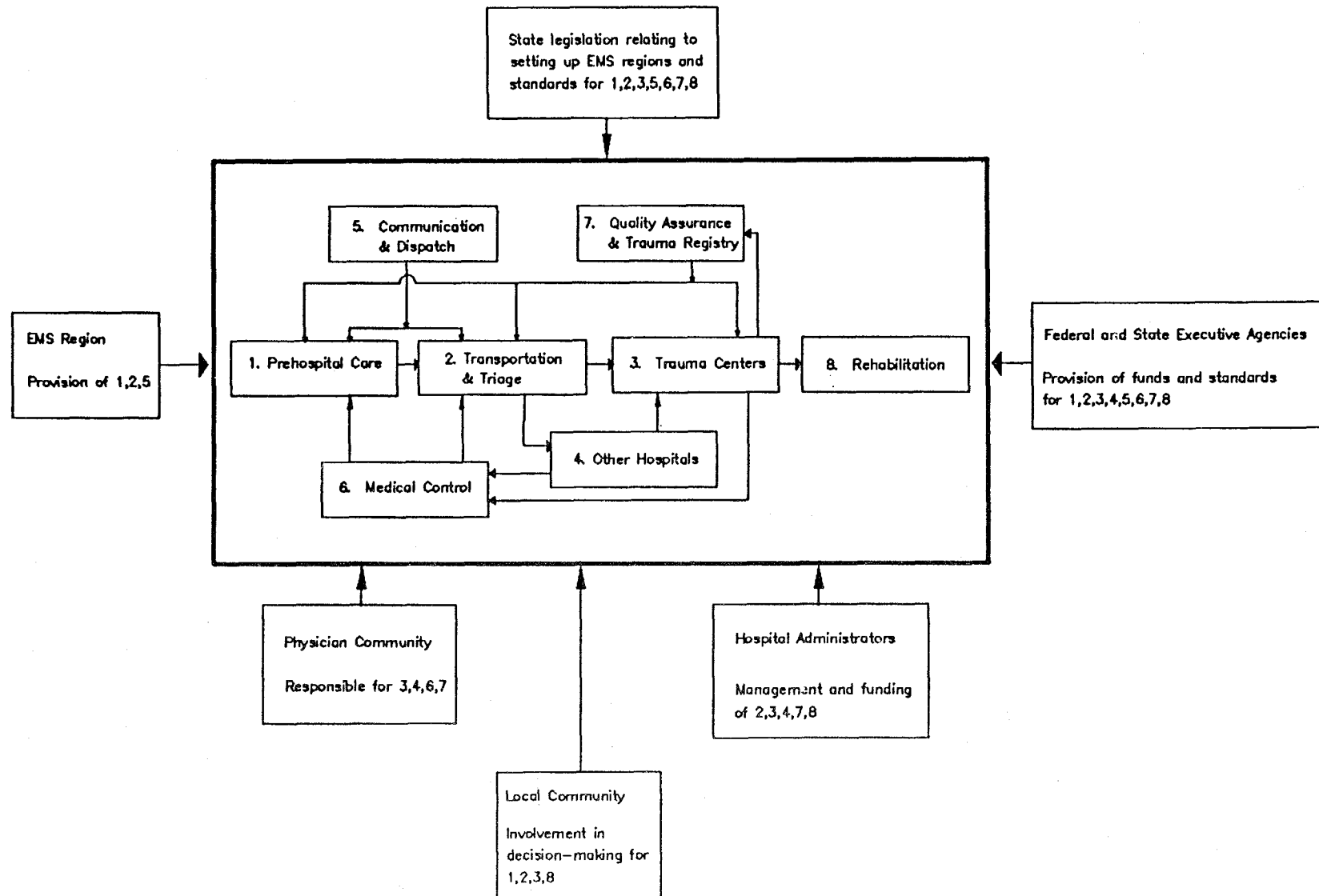
We now consider each of these factors in turn.

6.2.1 Legislative Action

Legislation is the cornerstone of a viable and successful trauma care system. Each of the eight component parts of a trauma system (as indicated inside the box in Figure 6-1) is established and regulated by appropriate legislation. Thus, legislation must:

- establish the designating authority for trauma centers (e.g., the state Department of Health, the County Board of Supervisors, an independent foundation);
- require plans to be drawn up for the establishment and functioning of the parts of the system--the prehospital care providers, the trauma center, other hospitals in the region, quality assurance procedures, training of EMTs, communications systems like 911;
- establish Emergency Medical Services Regions;
- provide for the trauma center's legal right to treat all serious trauma cases, as well as its obligation to treat all such cases regardless of ability to pay;

Figure 6-1
Trauma System of Care



- establish liability of hospitals, physicians, and EMTs that do not honor the trauma center's role as the primary provider of trauma care;
- provide funding for all or part of the trauma system and address the problem of uncompensated care.

It is very important that a designating authority be established, though it does not matter so much who that authority is. But it is important that this authority be one of designating, not just of categorizing, hospitals. The former means that the state (or the body to whom the state has delegated the authority) not only recognizes a certain hospital as meeting required standards (usually the standards set up by the Committee on Trauma of the American College of Surgeons), but that it also appoints that hospital (and only that hospital) to receive and care for trauma cases in its geographic region. Such a designated trauma center, therefore, is given not only the right but the duty to treat serious trauma. To not do so would be a dereliction of duty of the designated trauma center; to not give the designated trauma center the opportunity to treat a seriously injured person by taking him/her to another hospital would constitute malfeasance on the part of EMTs or paramedics as well as on the part of a non-designated hospital that agreed to treat such a patient. (Exceptions, of course, would be cases where a patient needs to be stabilized at a community hospital before being transported to the trauma center because of the long transport distance. No legal sanctions can be enforced, either, if the patient or his family insist on the patient being taken to a hospital that is not a designated trauma center.)

Categorization or verification of trauma centers is a much weaker procedure than designation. It merely means that an approved authority has determined or verified (either by a site visit or by examination of a hospital's self-description) that a hospital meets standards (again, usually those of ACS) of being a trauma center. With categorization there can be many--often too many-- trauma centers.³ Furthermore, the categorization is often done by a "paper verification;" i.e., by examining a hospital's application and what it says about the availability of its human and other resources. It is quite likely that hospitals will exaggerate the availability of their staff, for example. And since categorization, unlike designation, does not impose a duty on a hospital, hospitals may decide to drop their trauma center status, if they find that being a trauma center is onerous or costly.

Without strong state legislation, a trauma system cannot be assured. There may be a good trauma center, perhaps because of the leadership of a strong and

dedicated physician. In almost all existing trauma centers there is a history of a trauma surgeon who was the leading force behind the setup and operation of the trauma center, through the force of his personality and the work of his dedicated staff. Such trauma centers are always in danger of not outliving their founders; furthermore, the very thing that makes such a physician effective in operating the trauma center (i.e., his strong personality) may be counter-productive in the establishment of an entire trauma system, where many pieces must be fitted together and many persons must be made to work together.

State legislation can and must bring about by rules and institutional procedures what the dedicated trauma physician brings about by the force of his personality and will. And although rules and institutional procedures are less glamorous than personality and charisma, they do tend to last longer and--most importantly--to be replicable.

In areas where there is no explicit legislation about trauma center designation and trauma system functioning, even an existing good trauma center is often threatened and may be overcome by events. Things appear to be running smoothly in Amarillo, for example, because Northwest Texas Hospital functions as the trauma center for the region with the consent of the other two major hospitals in the region (High Plains Baptist and St. Anthony's). Yet, with the financial condition of all hospitals in the U.S. more and more precarious, the temptation to try and take some of the trauma patients from Northwest Texas Hospitals is ever present. In the Texas Panhandle, it is largely prevented by the EMTs who know where to take a trauma patient, and by the good will of the hospital administrators who continue the agreement made over a decade ago. Yet Northwest Texas Hospital has a far higher occupancy rate than the other two hospitals and this poses an ever-present threat to the continuation of the current system.

An opposite problem can be detected in Dade County (Miami), Florida. Florida's legislation is very permissive; any hospital that says it meets the requirements for a trauma center will be verified and categorized as one by the state. In Dade County, this led to many trauma centers--seven in all. But they were not a trauma system. One by one, they dropped out (de-certified themselves), because they found being a trauma center unprofitable. This left the entire burden of trauma care to Jackson Memorial Hospital, the county hospital. Here, strong state legislation could have mandated a trauma plan that might have let the hospitals see both the likely volume of trauma patients and the likely impact of uncompensated care. The "free

market" model let the hospitals see this only after the fact. Without such planning, trauma patients are now exposed to longer transport times than they would be if there were a well-functioning system. Thus, legislation must be used not only to establish the legal monopoly of the trauma center, but also to provide the necessary logistical and financial support for the trauma center.

It is also important for the legislature to establish EMS regions or, if these have already been set (as is the case in most states), then to determine what the duties and responsibilities of these regions are. This would usually include supervision of ambulance services, checking on their equipment, training EMTs, reviewing run reports and exercising quality control (with the help of a medical director) over the triage procedures and the treatments administered, as well as setting up and maintaining communications and dispatch systems (if possible, on a regional basis), and mounting public information and education efforts. As before, the legislature has it in its power to make EMS regions very strong institutions. The stronger the EMS region, the more likely it is that the regional trauma system as a whole will also be strong and effective (see below, Section 6.2.2). The EMS region is the only "actor" in the trauma system that has a region-wide perspective and responsibility; hence the importance of that regional authority being active and vigorous.

Finally, state legislation must address the funding issue: how to pay for "free" or uncompensated care. While much of blunt trauma (often incurred in automobile crashes) appears to be covered by insurance, penetrating trauma (knife and gunshot wounds) is much less likely to be covered. Hospitals, though agreeing in principle that they ought to take their share of uncompensated trauma care, are afraid that they will get too many of these patients and will be ruined financially by a commitment to be a trauma center. Unless the funding issue is addressed and solved, hospitals are not going to be willing to be designated as trauma centers and the entire trauma system is at risk. In today's competitive hospital climate, no hospital is going to voluntarily undertake a function that does not pay for itself.

6.2.2 Leadership Role of the EMS Regional Agency

In order for a trauma system to come to be, or in order to make a deficient system into a well-functioning one, someone has to take a leadership role. There are many component parts in a trauma system, some with antithetical interests. Hardly anyone is in a position to have an overview of the entire system, its status and its needs, except the regional EMS agency. It should take the leadership in establishing a trauma system.

This does seem to have been the case in Allentown, Sacramento and Amarillo. In each case, the EMS leadership was responsible for starting the movement toward a trauma system. Apparently this did not occur in Dade county, where EMS is handled by the fire department. Even though the emergency services provided appear to be very good (rapid response, well-working protocols, an excellent helicopter system), the fire department was not a big factor in establishing the trauma system. It is not clear whether this is due to the fact that EMTs and fire chiefs are county employees and so maybe limited in what they can or cannot advocate, or whether it has more to do with the Florida state system, which is weak and leaves most of the initiative with regard to trauma to the hospitals themselves.

It is clear why the EMS region is the logical agency to take a lead role in the establishment of a trauma system:

- as a regional agency, it has a regional outlook and can see what the problems of the region are.
- it has direct contact with the patients and sees the need for prehospital care, specialized trauma care, trauma surgeons, etc. all the way to the need for rehabilitation.
- prehospital care providers are especially sensitive to the need for triage protocols: they need to know where to take a trauma patient and they have to be sure that there is an appropriate place for the patient to go to.
- as the first contact which the public has when involved in an accident or a medical emergency, the EMS agency is in a good position to mobilize the public, increase awareness of the need for a trauma system, and raise funds.
- EMS and trauma centers are already linked in the public mind. Senate Bill 10 in the 100th Congress links funding to improve EMS and funding to improve trauma centers (and defray some of their uncompensated costs).

While it is probably true that a strong EMS agency by itself cannot assure that there will be a good trauma care system (the other factors such as legislation and physician support must also be there), it is true that without a strong leadership role by the regional agency, a good trauma system cannot come to be. No good trauma system that we saw or heard of existed without a strong regional EMS agency.

Local Involvement. Although in Section 6.2.1 we emphasized the importance of state action, it is also true, on the other hand, that local communities and local personnel must be responsible for the shape of the actual trauma system. Legislation

makes a trauma system possible; the actual setting up must be done by (or at least with the assistance of) local persons. The local community will "buy in" to the trauma system (i.e., use it, support it, and put the necessary pressures on those who don't want to cooperate with it), if they see the trauma system as something that is their own, not as something that is imposed on them by state (or federal) officials. The EMS agency can mobilize the local community.

The importance of local involvement was emphasized to us in several of the communities where we conducted site visits: in Amarillo and in Allentown, as well as in Oregon where the trauma system is just now being set up. In Oregon, a great deal of time is being taken to make certain that local communities are involved in the planning process for trauma centers and trauma systems; although this has slowed implementation, it appears to be paying off in that local communities are cooperating in the process and not resisting it. In Dade County, on the other hand, trauma centers were set up largely in response to one local hospital's aggressive action in offering to provide medical helicopter service. This led to fear that this hospital would siphon off all the trauma cases; in reaction, the county established a helicopter service and other hospitals had themselves verified as trauma centers. But the local communities--patients, EMS, doctors, nurses--were apparently not consulted. Two years later, Dade County's trauma care is in disarray; the fact that there was no system for which any one felt "ownership" is surely part of the reason.

In Amarillo, the system has had support from the beginning from the EMS regional agency (PEMSS), from the ambulance companies (many of them volunteer companies), from the county judges (the county administrators in Texas) and from the hospital administrators, since AERC (the Amarillo Emergency Receiving Center) was set up by agreement among the three major hospitals in the area. Physician support is also very important, as we shall see in the next section; in this respect there appears to be less than full support in Amarillo, perhaps because physicians feared (and still fear) AERC might take patients away from them.

In Allentown also there was deep and continuing involvement of all interested parties. The EMS council was involved, Lehigh Valley Health Center was, as were trauma surgeons. All eighteen hospitals in the region were involved in the trauma center designation process and were kept continuously informed; their opinion and advice was solicited. As a result, the trauma system in the area functions extremely well and is so perceived by its participants.

In California, there was considerable local involvement in the planning and design of the Sacramento EMS system. The Sacramento County Emergency Medical Care Committee appointed an Interim Trauma Plan Task Force to develop a plan for the interim system that was set up. Indeed, the creation of an interim system was a response to local input which indicated that EMS problems for severely injured persons needed to be solved quickly while an overall trauma system would take much longer to implement. In order to designate trauma centers, an RFP process was used, which itself mandates local involvement: only those hospitals that want to be considered for designation need to reply. As it turned out, because of various local considerations, only UC Davis Medical Center agreed to become a Level II trauma center; the next most likely candidate, Mercy San Juan Hospital, declined because its administrators felt they could not meet the standards required by the ACS guidelines.

Support of Physicians. Clearly support of local physicians is crucial to a well-functioning trauma system. It would seem at first blush that such support should be easy to obtain, but this is not necessarily so. There are several difficulties that must be overcome:

- Fear that the trauma system may take patients from attending physicians.
- Fear that many trauma patients may be non-paying (the stereotypical image is that of a severely injured motorcyclist who requires much care but who has no insurance).
- Trauma surgery, because of its unpredictable occurrence, is inconvenient. It may come in the middle of the night or it may interfere with a surgeon's private patients.
- Fear of malpractice suits in the Emergency Department setting where patient and doctor do not know each other.

The fear of malpractice suits may be able to be addressed through state legislation (extension of "good samaritan" laws to include physicians who extend emergency medical care). The fear of non-paying patients is an issue relating to the economic status of physicians and must be addressed in that context. Perhaps legislation can make clearer what a physician's obligations are in this respect and also what the limits of that obligation are, so that not all the free care falls on one, or a few, physicians.

The unpredictability of the occurrence of trauma is the reason, of course, why the guidelines of the ACS mandate that a trauma surgeon be immediately available at

any trauma center. In a Level I or II trauma center, a general surgeon and a neurologic surgeon are supposed to be available 24 hours a day. Teaching hospitals can generally meet this requirement through residents, but Level II trauma centers (which are not teaching hospitals) can only meet this requirement by having private physicians in-house and sleeping in the hospital. Many private physicians are unwilling to do this. In California, if a physician could be found to do it at all, he or she would have to be paid for staying at the hospital (about \$1,000 a day). This is one of the great obstacles to non-teaching hospitals becoming Level II trauma centers: having surgeons available 24 hours a day is almost impossible to achieve for such a hospital and, if it is achieved may be financially ruinous to the hospital.

Several times on our site visits we encountered the view that the 24 hour surgeon availability requirement was unrealistic for hospitals that otherwise saw themselves as capable of meeting Level II standards. It was suggested that having a surgeon available within 30 minutes was feasible and probably provided good enough care for the trauma patient. For example, this was the view in Sacramento, where Mercy San Juan Hospital was willing to apply for status as a Level II trauma center, if the 24-hour presence of a surgeon could be replaced by "on-call, available within 30 minutes." When, however, the Board of Supervisors (the designating authority) went back to the full ACS standards, Mercy San Juan withdrew its applications.

Northwest Texas Hospital in Amarillo is not, as we have already seen, an official Level II trauma center, since there is no designating authority in Texas. It functions like a Level II trauma center, but does not have 24 hour availability of a general surgeon; instead, it depends on a "call roster." If needed, surgeons and others specialists are called to the hospital and it was maintained that they generally can get to the hospital in five minutes. However, the entire "call roster" system threatened to break down, because not enough physicians were willing to be on call. At one point, only five or six surgeons were on the call roster, making it extremely difficult to provide 24 hour coverage seven days a week. It is an example of how much good trauma care is dependent on the cooperation and good will of local physicians.

The physicians' fear of losing patients if a trauma system is implemented is a serious and important one. If a hospital is a Level I or Level II trauma center, a surgeon will be on duty 24 hours a day, heading a trauma team. This surgeon and his team will take care of serious trauma patients, including -- most importantly -- performing the necessary lifesaving surgery. If there were no trauma system, the trauma surgery would be performed by the regular attending surgeons at the hospital -- generating

income for the attending surgeon, but endangering the patient's life because such a surgeon would not be immediately available at the hospital. The whole purpose of the trauma center and the standards as set by the American College of Surgeons is to have the surgical capacity immediately available: the trauma team ideally meets the patient at the Emergency Department door as he is being wheeled in by the EMTs.

It is common practice for Emergency Department physicians not to have admitting privileges (this was the case in Amarillo). Only those physicians who are prepared to take care of the patient in the hospital can admit a patient; the Emergency Department physician stays in the ED and does not follow the patient. This practice makes sense, and it also preserves income for the attending physicians who admit patients from the ED that then become "their" patients.

If the ACS's trauma team approach is followed, the emergency department physician is one member of that team; the leader, however, should be an experienced surgeon. This surgeon, of course, has admitting privileges. The consequence of this, to the remainder of the physician community, is that they are bypassed as far as trauma patients are concerned -- the trauma team, led by the trauma surgeon, will take care of trauma patients, in the ED and in the hospital.

Support of Hospitals and Their Administrators. Support of hospital administrators is needed because establishing the capability to be a trauma center can require considerable initial financial investment on the part of a hospital. We did not find this to be a problem in our site visits. In Amarillo, the administrator of Northwest Texas Hospital attributed his hospital's high occupancy rate to the trauma service -- a considerable percentage of the admissions to the hospital come from the AERC. In Dade County, the administrator of Jackson Memorial Hospital fully supported the trauma center. Uncompensated care is a big problem there, but he believed that as of the time of our conversation he was able to balance his books, taking into account insurance payments, Medicaid, and the County's contribution. (The fact that Jackson Memorial is the county hospital and as such gets a contribution from the county is one of the reasons why the administrators of other hospitals in Dade County were not eager to participate in the trauma system: the county made no contribution to them, even if they treated non-paying trauma patients.) Lehigh Valley Hospital Center in Allentown, Pennsylvania is fortunate in that revenues from its trauma service exceed the costs -- so it has the full support of administrators.

In the Sacramento area, the trauma center is the University of California's Medical Center at Davis. As a teaching hospital, it has residents available to provide

the coverage required by ACS guidelines. The hospital administration supports the trauma center but would like there to be another trauma center in the county — less for strictly financial reasons than to free up some hospital beds for other "missions" of the hospital. Too many trauma patients are being sent to UCD/MC by other hospitals, partly out of fear of liability if they attempt to treat trauma patients. Thus, there is a serious problem of overtriage. Support is required from the administrators of other hospitals to set up another trauma center.

6.2.3 Funding for Uncompensated Care

This is a very important factor. Again and again the fact that many trauma patients end up receiving "free" care is mentioned. It is a stumbling block to hospitals' embracing the idea of becoming a trauma center (see for example the Dade County experience). It is a factor everywhere. Particularly as hospitals are becoming more and more competitive, they are more and more interested in paying patients, not in indigent patients. Large teaching hospitals are probably in a better position to absorb losses of free care, just as they are in a better position to provide all the required coverage for a Level I trauma center than other hospitals.

The financial burden of free care varies greatly from hospital to hospital, as was apparent in our site visits. We saw in Chapter 5 (see Table 5-3) that uncompensated and uncollectable charges in the five sites varied from only 4% in Allentown to 73% in Dade County's Jackson Memorial Hospital.

Modest amounts of federal and state funds could go a long way toward solving this problem (as Senate Bill 10 already suggests). Safeguards would have to be established, of course, that such funds only go to appropriate hospitals; what must be avoided is hospitals vying to become trauma centers so they can share in a (perceived) federal largesse.

Few other things, however, are so easy to do as provide some additional money and can be seen so readily to promote good trauma systems. Attention to funding problems is especially important in today's financial climate where hospitals are squeezed on all sides to become more cost-conscious and get control of their charges. Trauma legislation typically mandates that a trauma center treat any trauma patient, regardless of his/her ability to pay. This mandate requires, in equity, that truly needed trauma care be paid for by those who lay down the mandate, i.e. the public through its legislators.

6.3 Recommendations to NHTSA

There are a number of things that NHTSA can and should do in order to promote trauma system development:

1. Work with other agencies on highlighting the problem of injury. The Public Health Service and the CDC are agencies with which NHTSA should join, to make the public aware that "injuries are no accident," that prevention is the most cost-effective way of combatting injury (NHTSA is already doing this through its safety-belt efforts), and that the cost of injuries is huge because it primarily affects young people whose societal contribution in wages and taxes is lost.
2. Public information and education. Trauma care is costly and ultimately the burden falls on the tax-paying public. They need to be educated as to the need for trauma systems, the benefits which they provide, and the costs incurred in setting them up.
3. Provide model legislation to states for trauma care and emergency medical services. Many states have good laws, but some have none and some of the existing laws are very weak.
4. Assist EMS regions in more and better training for EMTs/paramedics and provide training in PHTLS, ATLS and BTLs. As we saw, well-functioning trauma systems raise the expectations of what EMS should do. These expectations can only be met by better trained, more professional EMTs/paramedics.
5. In conjunction with the American College of Surgeons, Committee on Trauma, address the financial problems faced by hospitals that seek to provide Level II services. As non-medical persons, the authors of this report are in no position to dispute ACS's view that 24-hour coverage by surgeons and neurosurgeons is required. We do know that this requirement is keeping hospitals from applying to become (or stay) Level II trauma centers. The question to be addressed is: which way is the public served better, by rigorous adherence to current standards, resulting in few Level II hospitals, or by some relaxation of those standards and more Level II hospitals that have lower standards? It is a difficult trade-off and should be carefully examined. This might be done through convening a small workshop of experts to address this issue.
6. Some additional research ought to be done on the role of Level III hospitals. We encountered none in our site visit. A fully integrated trauma system needs them to provide region-wide coverage, but it ought to be found out why there are so few -- at least few that function in a total system.
7. Trauma registries may present a target of opportunity for NHTSA. They are important in quality assurance but their existence and operation is scattered and fragmentary. A modest

amount of research might uncover what is needed in trauma registries, what the obstacles to implementation are, and what support NHTSA might give them. Perhaps some small amounts of seed money funding could have considerable impact.

8. NHTSA should support the concepts of Senate Bill 10 in the 100th Congress. Of special interest for trauma care is the section of the bill that mandates a study of the reimbursement policies for trauma under DRGs.
9. NHTSA should work with the Health Care Financing Administration to see what can be done about funding trauma care under rules that seem to prohibit cross-subsidization. HCFA makes rules for Medicare patients and therefore is probably relatively uninterested in trauma, since trauma is a disease of young persons, not those over 65. However, HCFA's policies with regard to Medicare reimbursement are often taken as the model by states for their own reimbursement policies, including reimbursement for costs incurred by patients of all ages.
10. NHTSA should support the states and local communities to develop and implement system quality assurance programs, EMT training in trauma, and -- most importantly -- in conjunction with the states, address the problem of uncompensated trauma care.

Notes

- ¹ "Data from various regions in the United States suggest that there are 1,000 severe injuries annually per one million population" (American College of Surgeons, Hospital and Prehospital Resources for Optimal Care of the Injured Patient, Chicago, 1986, p.3). This translates into one serious injury per 1,000 population, or about 360 per annually for the Texas Panhandle. The same ACS document, two paragraphs later, states that a Level II trauma hospital should treat between 350 and 600 severely injured patients annually.
- ² Although rehabilitation is an important part of trauma care, research into rehabilitation procedures, facilities, costs and problems was beyond the scope of the present contract.
- ³ See, for example, the state of Illinois where recent legislation states that any hospital that meets standards shall be given the status of a trauma center. This is almost self-contradictory, since one requirement of the ACS standards is a sufficiently large caseload (600 serious trauma cases a year for a Level I trauma center) to prevent skill decay. If many hospitals are categorized as trauma centers, none probably can meet the caseload requirements.

ATTACHMENT I

Detailed Methodology

I.0 DETAILED METHODOLOGY

To address the objectives of this contract, we employed four different approaches:

1. We reviewed the literature on trauma, trauma centers and trauma systems.
2. We examined three sources of previously collected data that appeared to be especially promising, namely
 - a survey conducted by the EMS Clearinghouse for the National Association of State EMS Directors of all 50 states. The survey solicited information on trauma centers and trauma center designation
 - a survey conducted by NHTSA, through its regional offices, which also attempted to obtain information on current conditions of trauma centers
 - a study conducted by the U.S. General Accounting Office, titled Health Care: States Assume Leadership Role in Providing Emergency Medical Services. A chapter in that report is devoted to Cardiac and Trauma Care. Data for GAOs report were collected from six states.
3. An Abt study team visited five sites to collect data on trauma centers and trauma systems. In order to avoid duplication, three of the five sites were places that had also been studied by GAO.
4. We performed a statistical analysis of the effort of trauma center designation on hospitals, using nationwide data collected by the American Hospital Association.

Details of these four approaches are presented in the next sections.

I.1 Literature Review

To assist in the analysis of the development of the Trauma System, a literature review was conducted. The aim was to find technical information relating to the designation process of trauma centers and comprehensive trauma systems of care.

The sources for the literature search were the following:

- a. Articles and books available at Abt Associates as a result of prior work on EMS and on other health care-related issues.
- b. A list of relevant articles prepared by Dr. Charles McCabe, Assistant Chief, Emergency Medical Services, Massachusetts General Hospital. Dr. McCabe conducts an annual literature

review and produces an annotated bibliography on Trauma for the American Journal on Emergency Medicine, so that he was in an excellent position to provide us with a very complete list.

- c. We computer-searched three data bases: the National Library of Medicine, the TRIS base, and NTIS.
- d. A search was conducted of the NASA-RECON data base, but it turned up no useful citations.
- e. A number of individuals were asked to supply citations of relevant literature; several important articles were turned up this way. The individuals were:

Dr. Robert Cadigan, Senior Supervising Analyst, Office of Emergency Medical Services, Commonwealth of Massachusetts.

Gail Cooper, Chief, Emergency Medical Services, Department of Health Services, County of San Diego, California.

Michael Mears, Executive Director of the National Association of Emergency Physicians.

Charles Glass, Office of Enforcement and Emergency Services, National Highway Traffic Safety Administration.

- f. Because of its importance in the on-going discussion about injury and trauma care, we also reviewed Injury in America produced in 1985 by the Committee on Trauma Research, Commission on Life Sciences, National Research Council and the Institute of Medicine, and published by the National Academy Press.

These sources turned up an impressive number (more than 70) citations. Nevertheless, it cannot be claimed that this literature review was complete. The topic of trauma, trauma care and trauma systems is too dynamic and too much in the forefront of medical discussion to be easily contained; it seems that almost every week another article or note on the topic appears. We believe, however, that our review is as complete and thorough as was possible in two and one-half months, and that it gives a good picture of thinking at the end of 1986 about trauma.

The review categorizes the articles and books into five topic areas. These areas were largely determined by the goals of the overall study; namely, an understanding of the development of true trauma systems of care.

The five topic areas are:

1. Designation of Trauma Centers
2. Costs of Trauma
3. Studies Comparing Care With and Without Trauma Centers
4. Evaluations of Trauma Care
5. General Studies of Trauma Care

Below is a brief summary of what was found in each of these five areas. The complete Literature Review Report is included as Appendix C of this report.

Designation of Trauma Centers

Sixteen works--articles, books, reports, and surveys--were read and abstracted. Most of them deal with the standards which a hospital must meet in order to be designated a trauma center. (Determination of the designating authority is a matter of law. Legislation was not included in the literature review; instead, it is discussed separately in Chapter 3.)

Most trauma center designations rely on the standards proposed by the Committee on Trauma of the American College of Surgeons, "Hospital and Prehospital Resources for Optimal Care of the Injured Patient," or some modification of these. Both the 1986 and the 1983 editions of the guidelines are reviewed, as well as the verification program for hospitals that wish to be designated which was proposed by the American College of Surgeons (now abandoned because of fears that the ACS might be violating restraint of trade regulations if it implemented the program).

Guidelines for trauma care systems proposed by the American College of Emergency Physicians are reviewed, as is the report by the General Accounting Office, Health Care: States Assume Leadership Role in Providing Emergency Medical Services, prepared in 1986. This report--and the GAO staff notes which were used in its preparation--is frequently referred to in the following chapters of this report. (See also Section 2.2.)

The Commonwealth of Pennsylvania assigns the trauma center designation authority to the Pennsylvania Trauma Systems Foundation, a non-profit organization set up especially for this purpose (see Chapter 3). The standards for trauma center accreditation used by the Foundation are reviewed in this section. Other articles describe the process of designation in general; one article addresses the requests-for-proposal process used by the several states in their designation process.

Costs of Trauma

Eight articles on this topic are abstracted and reviewed. The costs of trauma include costs to the hospital, arising from "bad debt" or "free care" provided to uninsured or underinsured trauma patients, as well as insufficient reimbursement of trauma care costs by insurance companies and especially the federal government under the Medicare DRG regulations. Other costs that are discussed include the cost to the patient--which can be very high because of lengthy rehabilitation that may be required--and the cost to society, arising from lost wages and lost taxes as well as the unreimbursed costs of care.

Comparison of Care With and Without Trauma Systems

Twelve articles are abstracted and reviewed under this topic.

Trauma care before and after implementation of a trauma system is analyzed in a number of articles. Included are the seminal articles by West and Trunkey (1979) and several follow-up studies on preventable deaths (for example, by Drs. Cales and Trunkey), as well as the 1973 article by Dr. David Boyd. Of interest is that as early as 1973 in an article by Lowe, Gately, Goss, Frey and Peterson, a trauma system was outlined that has all the features that would be looked for today. Overall, the inescapable conclusion from the works reviewed in this section is that trauma centers and organized trauma care save lives.

Evaluation of Trauma Care

In ten articles, trauma care is evaluated using retrospective methods to arrive at estimates of "preventable deaths." Studies were conducted in many states, including California, New York, Vermont and South Carolina. Several studies evaluate trauma care in rural areas. The overall conclusion is that trauma centers save lives but that there is still room for improvement.

General Studies of Trauma Care

As the title indicates, these 30 articles contain a mixture of several kinds of studies. Salient points that emerge include:

- there is need to pay attention to prevention of trauma;
- injury is a major problem in America;
- the problem is economic as well as medical;

- there is a need for trauma registries; and
- in most parts of the country, trauma care still needs to be upgraded.

Included in this group of works is Injury in America produced jointly by the National Research Council and the Institute of Medicine. Its publication was followed by a CDC-sponsored conference on "Injury in America" in February of 1987. The book covers many topics beside trauma centers; it records the state of the art in injury research as of the end of 1986.

We should also note a book, Trauma Care Systems, edited by Richard H. Cales, M.D. and Robert W. Heilig, Jr., R.N., J.D., Rockville, MD, 1986: Aspen Publishers, Inc. It was received too late for inclusion in our literature review, but we have referred to it and copiously quoted from it throughout this report. Its twenty chapters and seven appendices provide a very comprehensive review of the state of trauma care and identify many important issues that need to be addressed by physicians, hospitals, prehospital care providers, legislators, and society at large.

I.2 Three Special Data Sources: EMS Clearinghouse Survey, NHTSA Survey, GAO Report

Our research included an examination of the current state of trauma systems and trauma centers. To do this, we used the following data sources:

1. A survey of all 50 states conducted by the EMS Clearinghouse of the National Association of State Emergency Medical Services Directors in Lexington, Kentucky. The survey was finished in July 1986.
2. We also reviewed a survey of all 50 states, conducted by NHTSA, through its regional offices, concerning trauma centers.
3. A report of prepared by the General Accounting Office and published in September 1986, Health Care: States Assume Leadership Role in Providing Emergency Medical Services

The EMS survey was conducted in early 1986. The information solicited dealt specifically with how trauma centers are designated in each of the fifty states. Results of the survey were summarized in a report titled State Trauma Center Programs: The Current Status.

Results of the survey may be summarized as follows:

- 18 states reported trauma center designation by state authority
- 6 states reported trauma center designation by other than state authority
- 27 states (including the District of Columbia) reported no trauma center program.

For ease of reference we here list the states in these three categories:

<u>Designation by State Authority</u>	<u>Designation by Other than State Author ity</u>	<u>No Trauma Center Programs Report ed</u>
*Alabama	California	Alaska
*Arkansas	Massachusetts	Arizona
Delaware	Minnesota	Colorado
Florida	Nebraska	Connecticut
Georgia	New Hampshire	Dis. of Columbia
Idaho	Pennsylvania	Hawaii
*Indiana		Illinois
Maryland		Iowa
Missouri		Kansas
New Mexico		Kentucky
North Carolina		Louisiana
Oregon		Maine
Rhode Island		Michigan
South Carolina		Mississippi
Tennessee		Montana
Utah		Nevada
Virginia		New Jersey
West Virginia		New York
		North Dakota
		Ohio
		Oklahoma
		South Dakota
		Texas
		Vermont
		Washington
		Wisconsin
		Wyoming

*Currently inactive program

The list must be read with some caution. First of all, it addresses only trauma center designation; it does not address the concept of trauma systems. Second, the list may be misleading, if it is thought that state designation is likely to be indicative of a stronger and better system of trauma care than non-state designation. Some of the states with state designation have well-functioning systems; others have no systems as

yet; still others have systems that are in serious difficulty. Arkansas, listed as having state authority designation, nevertheless has no trauma centers and an inactive trauma program. Oregon, which has no trauma centers, is in the middle of a well-defined process to designate trauma centers. In Florida, state designation means that the state will "verify" any hospital as a trauma center that certifies itself as meeting the standards of ACS and that pays application fees.

Third, some of the states that do not report a Trauma Center Program, nevertheless have large and well organized trauma systems. For example, Illinois has many trauma centers, even though it does not have, at the present time, a formal trauma center system.

Fourth, some states where the designation is not by the state, but by some other authority have extremely well-functioning systems. California, for instance, delegates the authority to counties or multi-county regions; Pennsylvania has given the authority to a special non-profit foundation. In short, state designation by itself is not sufficient to assure a high-level trauma system.

There is much other valuable information in the EMS Clearinghouse report (see its Table of Contents). Altogether, the report finds that there were 166 trauma centers in the United States at the time of the survey.

In 1986, NHTSA also conducted a survey, through its regional offices, to discover which states had trauma centers, as well as some other emergency medical services provisions. These data complemented what we had already received from the EMS Clearinghouse.

From these two data sources (plus a few phone calls) we were able to compile a list of trauma centers in the United States, in 1986. A copy of this list is attached as Appendix B. Only states that had trauma centers were listed.

The list is very uneven and demonstrates that at the present time there is no uniformly applied standard for trauma systems. Some states have many trauma centers (especially Illinois and Missouri); others have none (for example, Arkansas, Colorado and Connecticut are totally omitted from the list). Methods of designation vary, as do dates of designation. Levels of designation vary -- South Carolina has only Level I trauma centers while Iowa has only Level IIs. It is apparent from the list that in many places of the country trauma patients would not receive the care appropriate to their injuries.

The General Accounting Office, in response to a request from Senators Alan Cranston and Edward M. Kennedy, prepared a report (dated September 30, 1986) on state and local emergency medical services programs. The report addresses several topics that were of interest to us in our examination of existing trauma systems. Among these were access to the EMS system and dispatch of ambulances in response to emergencies (discussed in Chapter 3 of the report) and cardiac and trauma care, discussed in Chapter 5, with a subtitle "More Systematic Routing of Trauma Victims Needed."

To obtain information, the GAO held discussions with a variety of expert informants in governmental and private agencies. Most importantly, from our point of view, they made site visits to six states and 18 localities within those states in order to obtain information on state and local practices concerning EMS and trauma care. The six states were California, Florida, Iowa, Massachusetts, Pennsylvania and Texas.

Abt Associates was charged to make site visits to five localities; one of these was to be a site without a current trauma system (for which we chose Bend, in the state of Oregon). For the other four states, we decided to visit the same localities as GAO if possible, so that we might benefit from their prior effort in data collection. We were able to do this in three sites: Sacramento, California; Dade County, Florida; and Amarillo, Texas. Like GAO, we visited the state of Pennsylvania; however, GAO had chosen Harrisburg as their locality. We chose, instead, to visit Allentown, because it had a Level I trauma center and a well-functioning trauma system, while Harrisburg does not yet have a designated trauma center. Since Pennsylvania was included in our list because of its special designating mechanism (by the non-profit Pennsylvania Trauma Foundation), we needed to have a site where that foundation had actually exercised its designating authority, so that we could evaluate this designation method and compare it to other methods.

With the help of NHTSA we were able to obtain the cooperation of GAO for our study. They generously let us use the field notes which their staff had collected in Dade County, Sacramento, and Amarillo. This not only enabled us to shorten our own site visits; it also avoided asking the same questions of the same informants twice within twelve months.

I.3 Site Visits

A major source of information for us (as it had been for GAO) were site visits to five localities. Through discussions with a variety of informants and collection of existing local source materials (for example, triage guidelines), we obtained information on the existing trauma system (if any) at the site, as well as plans for changes, needed improvements, existing and anticipated difficulties and prospects for the future. Reports on the site visits were completed shortly after each visit; they are included in Appendix E of this report. These reports, together with notes taken by the site visitor, documents obtained during the site visit, and the GAO field notes, constituted the major input into Chapters 3, 4 and 5 of this report.

I.3.1 Choice of Sites

One of the requirements of this contract was to "identify the various methods in which trauma systems [are] implemented, e.g., self-designation, regional designation, State designation, professional designation, and others discovered through review of literature....

"Once the systems of trauma care have been identified....along with the various methods of trauma center designation, the contractor shall select sites for further research and study, which cover all categories of designation" (Work Statement, Task 3).

We identified four methods of designation and chose sites to represent each:

- State verifies hospitals as meeting standards (usually of ACS), but does nothing beyond a "paper verification." Any and all hospitals that say they meet standards will be verified. State: Florida. Site selected: Dade County
- State designates limited number of trauma centers. Designating authority may be delegated to other governmental entities, such as counties or multi-county regions. State: California. Site selected: Sacramento County
- There is no state or other governmental designation. Hospitals self-designate if they feel they can meet the trauma needs of patients. State: Texas. Site selected: Amarillo
- State delegates designation authority to a special, not-for-profit foundation which is charged with designating trauma centers according to ACS or other standards. State: Pennsylvania. Site selected: Allentown.

One site, according to the work statement, was to be "a State/Region which does not have the critical patient mass to have a designated trauma center" so that we could recommend "what strategies NHTSA should implement in assisting States which fall into this category."

- For this site we chose eastern Oregon, the area around Bend. It not only meets the criterion of not having a critical mass of patients, but also has problems arising from its mountainous territory. On the positive side, Oregon is in the process of developing a good trauma system with full involvement of local authorities. State: Oregon. Site selected: Area Trauma Advisory Board (ATAB) Seven with headquarters in Bend.

Table I-1 summarizes the sites selected and the criteria by which they were chosen.

I.3.2 Data Collection

From four to six person-days were spent at each site. Before visiting a site, we obtained permission and cooperation from the sites and the local trauma center. As much as possible we attempted to schedule appointments before our arrival so that a maximum amount of time could be spent at the actual interviews and as little as possible on administrative details such as setting up convenient times for appointments. We tried to interview all of the following persons:

- Regional EMS Director
- Trauma Center Administrator
- Administrators of other hospitals
- Trauma surgeon
- Trauma nurse and other members of trauma team
- Selected EMS personnel, including dispatcher
- Head of trauma registry
- Helicopter-knowledgeable person

Not all persons were available at all sites; where necessary we substituted other persons with similar areas of responsibility and knowledge. We also attempted to obtain the state view of the local trauma centers and systems. Accordingly, we visited state EMS directors in Tallahassee, Florida; Harrisburg, Pennsylvania; Sacramento, California. The state EMS office in Oregon is located in Portland, so we interviewed a person in that office in Portland. In Texas, we did not visit Austin; instead we talked with the Program Administrator for EMS in Public Health Region I in Canyon, Texas. Amarillo is located in Public Health Region I.

Table I-1

Proposed Study Sites

<u>Location</u>	<u>Method of Designation</u>	<u>Number of Trauma Centers</u>	<u>Urban/Rural</u>
1. Dade Co., FL	By state. "Free market" model; state will verify any hospital as a Trauma Center if it meets ACS standards.	One Level I. Originally there were also six Level IIs	urban
2. Sacramento, CA	By county or regional authority.	One Level II (university-affiliated)	mixed
3. Amarillo, TX	Self-designation. State "recognizes" but does not certify Trauma Centers.	Northwest Texas Hospital receives all trauma, but does not meet ACS standards for Level I or II.	mixed
4. Allentown, PA	In Pennsylvania, designation is done by a non-profit organization (Pennsylvania Trauma System Foundation) set up for the purpose.	Lehigh Valley Hospital is Level I.	urban
5. Eastern Oregon	By state	In rural areas, a number of "Level IVs" are to be identified, if caseload and other criteria for Levels I, II and III cannot be met.	rural

When we discovered lacunae in our notes after returning from the site visits, we attempted to obtain the needed information by telephone. Having made an initial in-person visit, we were acquainted with the persons we needed to call and generally had good luck in obtaining the information we required. All of the sites were extremely cooperative in assisting us in our data collection and provided ample, candid information to our questions.

Figure I-1 presents the interview guidelines which we used in eliciting information in our interviews. Often, of course, the interview went in different directions; we did not discourage our respondents from providing information which they felt was important.

Examination of the interview guidelines gives a good idea of what were the important issues that we tried to obtain information on. This list of issues was derived from the literature review, from conversations with knowledgeable persons, and, of course, from the respondents themselves, who supplied additional issues and/or problems that they felt we should investigate.

I.3.3 Financial Data

An important concern on which we wanted to obtain more information was financial. What are the financial implications for a hospital if it is designated as a trauma center? Are these implications positive or negative? What are the financial implications for other hospitals in the trauma center's catchment area? The literature provided conflicting information on these points: some evidence suggests that hospitals very much desire to be designated as trauma centers because of the revenues which they anticipate from trauma patients, including a beneficial impact on the hospital's occupancy rate. Other evidence shows that being a trauma center is a very costly proposition, because of the strict standards to which a hospital is held. Level II trauma centers particularly suffer from having to meet these standards: since they are not teaching hospitals, they have no cadre of residents on which to call to provide the needed 24-hour coverage of surgical care. Hence they must provide this coverage at frequently very high cost.

There is also the question of whether trauma patients, as a group, are responsible for more bad debt than other patients. There is anecdotal evidence that suggests that this may be so; several respondents referred to uninsured motorcyclists (also mentioned in the literature review) and to patients with penetrating trauma (gunshot and knife wounds) as sources of costly but unreimbursed care for hospitals.

Figure I-1

Interview Guides

INTERVIEW GUIDE: REGIONAL EMS

1. Standard questions on organization, structure, incentive and disincentives for participants.
2. How well is the system working? What are the problems? And solutions?
3. What methods are used for quality assurance?
4. How many trauma cases are there annually? Are there enough resources available to meet the need? Is there overuse or underuse of the system?
5. How is commitment, a key factor to success, demonstrated in this program?
6. What has the effect been on the non-participants in the trauma system? How have they responded to trauma system development?
7. What kinds of data collected and reports generated?
8. What was the planning process like? Who have turned out to be the key players-- is it role or personality that is important?
9. What resources have been allocated to the system? Is it sufficient? Where are the shortfalls?
10. What do you expect of the future? What issues to resolve? What methods are used to assure continuation?

INTERVIEW GUIDE: TRAUMA CENTER
(Respondents: Administer of Trauma Center)

Figure I-1
Continued

1. Standard questions on organization and structure. Which standards does the center meet? Does it really meet them?
- 1A. How does the center participate in the administration, coordination, and management of the trauma system? What does it cost? Who bears the cost?
2. What are the incentives and disincentives to becoming a trauma center.
3. What resources have been allocated to trauma care. Personnel, equipment. Both in-patient and out-patient. (Get specific. Get budget copies.)
4. One of the major factors in success is thought to be commitment: How is that demonstrated here?
5. What has the effect been on this hospital? Financial? Other? Revenues? Free care problems? Staffing changes, etc.?
6. What is the caseload? Is there overuse or underuse?
7. What kinds of trauma patients are likely to require free care? What portion of caseload is free care? Medicaid? Medicare? Commercial insurance?
8. How have the neighboring hospitals in the service area responded? How have they been affected?
9. What kinds of studies have you undertaken around trauma system participation? What were the issues? What results?
10. What are the major issues facing the trauma system? What will happen?
11. What the major issues facing the trauma center? What will happen?
12. What kinds of quality assurance methods are used?
13. What kinds of rehabilitation services are available for trauma patients? Is the current supply sufficient?
14. What kind of training is available for trauma service personnel?
15. How is coverage of the emergency department handled by physicians?

INTERVIEW GUIDE: OTHER HOSPITALS

1. What effect has the Trauma Center designation had on your hospital?
 - In terms of patient flow
 - In terms of financial implications
2. Are you interested in Trauma Center designation? Why or why not?
3. What are the incentives or disincentives to becoming a Trauma Center?
4. Why do you think (name of Trauma Center) did it?
5. How well do you think the Trauma System works?

INTERVIEW GUIDE: TRAUMA SURGEON

(Respondents:)

1. What do you think of the ACS standards? Are they too demanding? What is the most efficient arrangement for meeting those standards?
2. Does the trauma center designation benefit the patient? Has it changed the quality of care in this hospital?
3. How well does the current system operate? With respect to:
 - triage
 - cooperation or turf problems
 - cost
 - support problems
 - service for minority populations (equity of services)
4. What is the effect on community hospitals? On the Level II Trauma Center (if there is one)?
5. Do you think teaching status is a benefit or a disadvantage to
 - patients
 - the Trauma Center
 - overall system operation?
6. What are the staffing patterns? Number of surgeons? How is the OR coverage paid for? Any difficulty in recruiting MDs?
7. How important do you think the trauma service is in relation to the rest of the hospital services--annual allocation of resources, etc.
8. What methods do you use for quality assurance?
9. Do you have a trauma registry? Does it work? Is it useful?
10. How do you think commitment is demonstrated by the hospital? By the trauma surgeons? By the trauma service?
11. What are the most important factors for success of a trauma system?
12. What are the major stumbling blocks to success of a trauma system?

INTERVIEW GUIDE: PREHOSPITAL CARE

(Respondents: Ambulance Services, ALS, BLS)

1. How is prehospital trauma care organized? Who is involved? Who is not involved? How are the non-participants effected by the trauma system? What have the changes been for the participants.
2. What are the incentives, disincentives for participation?
3. How is continuity provided--between prehospital and the rest of the system?
4. What have the problems been? How were they resolved? What are the current and future issues?
5. What methods used for quality assurance?
6. What kinds of data collected and reports generated?
7. What resources are allocated. What personnel and equipment? Why those choices? What are the costs? (Get copies of budget) How are costs recovered? Who pays?
8. What kinds of training required for prehospital care? Who provides it?
9. Utilization data. Is the system overused or underused?
10. Is there control by a physician in prehospital care?
11. In triage, what standards (or protocols) are used to determine who goes to the center and who goes to the nearest hospital?

INTERVIEW GUIDE: COMMUNICATION AND DISPATCH

1. How is communication organized? Costs (personnel, support).
2. What was development like? Planning process, etc.
3. How is communication linked into the total system?
4. What are the problems? Issues to be addressed?
5. Same questions regarding dispatch.
6. What do you look for in hiring a dispatcher? Background? Training?

INTERVIEW GUIDE: AUTHORITY OF DESIGNATION

(Respondents: State EMS, Regional EMS Director, TC Administrator)

1. What is the ideal model for a trauma system as it is conceptualized in this state (county, region)?

Access to care.
Prehospital care.
Hospital care.
Rehabilitation.
2. How close to the ideal has real development been? What have been the major issues in development? How were they dealt with; are they resolved? What is left to do? What compromises were made?
3. How is the current system organized?
4. Describe the planning process. Who included? Formal arrangements for committees, etc. What were the original goals and impetus? To what extent were non-health care professionals involved?
5. What are the arrangements for administration, cooperation, management involved? Who bears the costs of these? What are the problems?
6. If you were consulting to a hospital, what expenditures would you tell that hospital to anticipate? In what areas?
7. What are the incentives and disincentives to involvement in a trauma system? For the prehospital care providers? The hospital? Other participants?
8. What standards are used? How often are reviews scheduled?
9. What are the arrangements for quality assurance in the trauma system?
10. One of the major factors in trauma system success is commitment: how is that demonstrated in this area?
11. What kinds of data are collected and reports generated? (Get copies)
12. Designation is often called political: How did this manifest itself here? Is "political" perjorative in this case?

To answer these questions, we collected two kinds of data:

- data from hospital administrators or financial officers on the cost of running a trauma service or a trauma center, taking into consideration such things as staffing, availability of operating rooms, extra equipment, etc. The instrument we used is presented in Figure I-2.
- patient-level data. We requested charge data on a sample of 50 patients at each trauma center, together with an analysis of how much of the charges was paid, who paid for it, and what was written off as bad debt.

The data we obtained were uneven. Since they come from only four hospitals, they are in any case not suitable for statistical inference. They may shed some light, however, on the opposing claims of trauma centers being either financial panaceas or causes of financial ruin.

I.4 Statistical Analysis of the Effect of Trauma Center Designation on Hospitals

In addition to the case study information which we obtained from the five site visits, we also wondered whether it might be possible to detect if trauma centers, as a group, are different from other hospitals by statistically analyzing data on all hospitals in the United States, which are collected by the American Hospital Association and which Abt Associates has available. Dr. David Kidder, of Abt Associates Health Economics Research Group, performed the analysis.

It is clear that hospitals with trauma centers are different from other hospitals. They are larger, in staff, bed size and volume of services delivered. They are more likely to be teaching institutions, located in urban areas. They tend to incur higher average costs per day but, because stays are somewhat shorter than in non-trauma hospitals, lower costs per admission.

In this form, however, statistics about trauma centers tell little about why such differences exist. Trauma hospitals might have been larger and higher in per diem costs before they installed a trauma program. They might have operated in markets that were systematically different, in competitiveness, in the supply of health resources, in critical demographic characteristics, from non-trauma centers' markets. Even if becoming a trauma center does have some effect on volume and costs, the effect may be buried among confounding factors, such as ownership, teaching status, etc. that are equally and perhaps more important determinants of these outcomes.

Figure I-2

Guide for Cost Questions

Cost of Trauma Service

1. Do you use a trauma team model?

Yes []

No []

IF YES: Is the team dedicated exclusively to trauma care?

Yes []

No []

2. How many physicians are on your trauma team?

Physicians

3. How many of your trauma team physicians are paid for the time they spend on call?

Physicians

4. IF ANY TRAUMA TEAM PHYSICIANS ARE PAID:

What is the annual cost* to the hospital of payments to trauma team physicians?

\$ _____

*Whenever annual costs are asked for, please give either actual costs for the last fiscal year or the amount budgeted for the current fiscal year. Indicate here which you are using:

Last fiscal year actual cost []

Current fiscal year budgeted cost [].

5. How is 24 hour in-house coverage provided?

	Staff specialist in house?				Resident, with staff on prompt call?					
	Yes	No	If yes, is the staff specialist paid specifically for this?		Yes	No	a. If yes, is the resident paid over and above his salary for this?		b. If yes, is the staff specialist on call paid for being on prompt call?	
			If yes, enter the total cost/year for this coverage	No			If yes, enter the total cost/year for this coverage	No	If yes, enter the total cost/year for this coverage	No
General surgery										
Neurosurgery										
Emergency Medicine										
Anaesthesiology										

6. What arrangements are made to provide a first assistant for trauma surgery?

7. What arrangements are made to provide for the other surgical specialties that are required to be on-call and promptly available 24 hours a day?

Cost/year for this coverage _____

8. What arrangements are made to provide for the other non-surgical specialties that are required to be on-call and promptly available 24 hours a day?

Cost/year for this coverage _____

9. Do you have more staff in the Emergency Room 24 hours a day than you would if you did not offer trauma service?

Yes [] No []

If yes, please identify the staff by function.

Cost/year for this coverage _____

10. In the Emergency Department, do you have a two-way radio linked with vehicles of the emergency transport system?

Yes [] No []

If yes, what is the cost of this per year?

11. Do you have more staff in the Intensive Care Units than you would if you did not offer the trauma service?

Yes [] No []

If yes, please identify the staff by function. _____

What is the extra cost of this staff per year? _____

12. In terms of 24 hour radiologic capacity, are the arrangements for CT technician coverage more extensive than they would be if you did not offer the trauma service?

Yes [] No []

If yes, what is the cost of this per year? _____

13. Do you have one or more operating rooms dedicated to trauma service exclusively (i.e. always fully staffed and ready)?

Yes [] No []

If no, what are the arrangements for 24 hour capacity of the operating room? _____

If there is any extra cost for these arrangements, please indicate what the cost per year is. _____

14. Please provide a description of your quality assurance program.

If these quality assurance activities exceed the standard for the rest of the hospital, what is the extra cost per year? _____

15. Are there annual costs to providing a trauma service that are not covered in the earlier questions?

Yes []

No []

If yes, please specify below and provide the annual costs. _____

16. Looking back at all of the previous questions, what is the total annual cost for staffing and for equipment attributable to the trauma service? _____

In order to isolate the "trauma center" contribution, estimates of outcomes have to be adjusted, to remove confounding influences. One way to do this is through multiple linear regression, a statistical technique that allows the investigator to measure the influence of many factors on certain outcomes. The technique produces coefficients for each factor that can be interpreted as the influence of that factor, holding all other measured influences constant. The "net" contribution to any changes in cost, for example, of becoming a trauma center (irrespective of bed size, location and other factors) can thus be captured in one or more coefficients of a regression equation.

The technique used here to detect trauma effects is known as a "four way" evaluation design, because it utilizes contrasts between trauma and non-trauma hospitals and comparisons over time, before and after implementation of the trauma program. For example, before implementation we estimate a cross-sectional contrast for cost per day:

A.	Trauma hospitals average cost/day	-	Non-trauma hospitals average cost/day	BEFORE
----	--------------------------------------	---	--	--------

After implementation, we have the relation:

B.	Trauma hospitals average cost/day	-	Non-trauma hospitals average cost/day	AFTER
----	--------------------------------------	---	--	-------

The effect of becoming a trauma center is the difference (B - A). If trauma hospitals were more expensive than non-trauma hospitals before they implemented their programs, and were equally expensive after, then $B - A = 0$: becoming a trauma center had no net effect on cost per day. But if B is larger (or smaller) than A, then, providing that possible confounding influences have been accounted for, it can be asserted that implementing a trauma center is associated with an increase (or decrease) in cost per day.

The report on the effect of trauma designation is included as Attachment III.

ATTACHMENT II

List of Trauma Centers

TRAUMA CENTER LIST

KEYEMS = EMS Clearinghouse
Survey, February 1986NHTSA = Survey of Regions,
July 1986

NO.	NAME	LEVEL	DATE OF DESIGNATION	SOURCE	DESIGNATED BY
<u>ALABAMA</u>					
1	Baptist Medical Center, Montclair, Birmingham	II		NHTSA	
2	Baptist Medical Center, Princeton, Birmingham	II	3/18/81	NHTSA	Self
3	Bessemer Carraway Medical Center, Bessemer	II		NHTSA	
4	Brookwood Hospital, Birmingham	II	3/18/81	NHTSA	Self
5	Carraway Methodist Medical Center, Birmingham	I	4/19/80	NHTSA	Region
6	Cooper Green Hospital, Birmingham	II	10/2/72	NHTSA	Region
7	Druid City Hospital, Tuscaloosa	II	7/14/80	NHTSA	State
8	East End Memorial Hospital, Birmingham	II	'78	NHTSA	Region
9	Eliza Coffee Memorial Hospital, Florence	II		NHTSA	
10	Huntsville Hospital, Huntsville	I	4/8/80	NHTSA	State
11	Lloyd Noland Hospital, Fairfield	II		NHTSA	
12	University of Alabama Hospitals, Birmingham	I	'79	NHTSA	State
<u>CALIFORNIA</u>					
1	Antelope Valley Hospital Medical Center, Lancaster		10/13/84	NHTSA	County
2	Cedars-Sinai Medical Center, Los Angeles		4/19/84	NHTSA	County
3	Children's Hospital & Health Center, San Diego		8/1/84	NHTSA	County
4	Children's Hospital of Los Angeles, Los Angeles		12/15/83	NHTSA	County
5	Daniel Freeman Memorial Hospital, Inglewood		6/25/84	NHTSA	County
6	Harbor-UCLA Medical Center, Torrance		12/15/84	NHTSA	County
7	Henry Mayo Newhall Memorial Hospital, Valencia		10/16/84	NHTSA	County
8	Hollywood Presbyterian Medical Center, Los Angeles		2/28/84	NHTSA	County
9	Holy Cross Hospital, Mission Hills		4/23/84	NHTSA	County
10	Huntington Memorial Hospital, Pasadena		12/13/83	NHTSA	County
11	Kaweah Delta District Hospital, Visalia		winter '83	NHTSA	County
12	LAC/USC Medical Center, Los Angeles		12/84	NHTSA	County
13	Martin Luther King, Jr., Los Angeles		12/15/83	NHTSA	County

NO.	NAME	LEVEL	DATE OF DESIGNATION	SOURCE	DESIGNATED BY
	<u>CALIFORNIA</u> (continued)				
14	Memorial Hospital Medical Center of Long Beach, Long Beach		12/15/83	NHTSA	County
15	Mercy Hospital and Medical Center, San Diego		11/85	NHTSA	County
16	Methodist Hospital of Southern California, Arcadia		3/27/84	NHTSA	County
17	Northridge Hospital Medical Center, Northridge		6/19/84	NHTSA	County
18	Palomar Memorial Hospital, Escondido		1/1/85	NHTSA	County
19	Presbyterian Intercommunity Hospital, Whittier		8/5/85	NHTSA	County
20	Queen of the Valley Hospital, Napa		4/84	NHTSA	State
21	Queen of the Valley Hospital, West Covina		2/1/84	NHTSA	County
22	St. Joseph Medical Center, Burbank		5/13/84	NHTSA	County
23	St. Joseph's Hospital, Stockton (not yet designated)			NHTSA	
24	St. Mary Medical Center, Long Beach		12/15/83	NHTSA	County
25	San Francisco General Hospital, San Francisco		4/5/85	NHTSA	State
26	Santa Rosa Memorial Hospital, Santa Rosa (not yet des.)			NHTSA	
27	Scripps Memorial - La Jolla, La Jolla		6/5/84	NHTSA	County
28	Sharp Memorial Hospital, San Diego		8/1/84	NHTSA	County
29	Sierra View District Hospital, Porterville		6/86	NHTSA	County
30	Stanford University Hospital, Palo Alto		2/12/86	NHTSA	County
31	Tulare District Hospital, Tulare		6/80	NHTSA	State
32	UCLA Hospital and Clinic, Los Angeles		12/15/83	NHTSA	County
33	UCSD Medical Center, San Diego		5/84	NHTSA	County
34	Valley Medical Center, Fresno		6/85	NHTSA	County
35	Valley Medical Center, San Jose		2/14/86	NHTSA	County
36	Westlake Community Hospital, Westlake Village		10/84	NHTSA	County
	<u>DELAWARE</u>				
1	Christiana Hospital, Newark	I	5/21/84	EMS	
	<u>DISTRICT OF COLUMBIA</u>				
1	Children's Hospital (pediatric)	I	4/86	RB*	D.C.
2	D.C. General Hospital	I	4/86	RB	D.C.
3	Georgetown University Hospital	I	4/86	RB	D.C.
4	George Washington University Hospital	I	4/86	RB	D.C.

*Personal communication from Ruth Brannon, MSPH

NO.	NAME	LEVEL	DATE OF DESIGNATION	SOURCE	DESIGNATED BY
	<u>DISTRICT OF COLUMBIA</u> (continued)				
5	Greater Southeast Community Hospital	II	4/86	RB	D.C.
6	Howard University Hospital	I	4/86	RB	D.C.
7	Washington Hospital Center	I	4/86	RB	D.C.
	<u>FLORIDA</u>				
1	Baptist Hospital, Pensacola	II	3/85	EMS	
2	Baptist Hospital of Miami, Inc., Miami	II	6/85	EMS	
3	Baptist Medical Center, Jacksonville	II	3/85	EMS	
4	Bayfront Medical Center, St. Petersburg	II	9/84	EMS	
5	Brookwood Community Hospital, Orlando	III	8/84	EMS	
6	Florida Hospital, Orlando	III	4/85	EMS	
7	Halifax Hospital Medical Center, Daytona Beach	II	12/85	EMS	
8	Hialeah Hospital, Hialeah	II	6/85	EMS	
9	Humana Hospital, Orlando	III	11/85	EMS	
10	Humana Hospital Northside, St. Petersburg	II	11/85	EMS	
11	Jackson Memorial Hospital, Miami	I	4/85	EMS	
12	Methodist Hospital, Jacksonville	II	6/85	EMS	
13	Mount Sinai Medical Center, Miami Beach	II	5/85	EMS	
14	Memorial Medical Center, Jacksonville	II	4/85	EMS	
15	Mercy Hospital Inc., Miami	II	9/85	EMS	
16	Orlando General Hospital, Orlando	III	5/85	EMS	
17	Orlando Regional Medical Center, Orlando	I	5/85	EMS	
18	Parkway Regional Medical Center, North Miami Beach	II	6/85	EMS	
19	Sacred Heart Hospital, Pensacola	II	4/85	EMS	
20	St. Lukes Hospital, Jacksonville	II	9/85	EMS	
21	St. Vincent's Medical Center, Jacksonville	II	10/85	EMS	
22	South Miami Hospital, Miami	II	7/85	EMS	
23	Sun Coast Hospital, Largo	II	3/85	EMS	
24	Tallahassee Community Hospital, Tallahassee	III	8/85	EMS	
25	Tallahassee Memorial Regional Medical Center, Tallahassee	II	9/85	EMS	
26	Tampa General Hospital, Tampa	I	4/86	EMS	
27	University Hospital of Jacksonville, Jacksonville	I	2/85	EMS	
28	West Florida Hospital, Pensacola	II	2/85	EMS	
29	Winter Park Memorial Hospital, Winter Park	III	4/85	EMS	

NO.	NAME	LEVEL	DATE OF DESIGNATION	SOURCE	DESIGNATED BY
<u>GEORGIA</u>					
1	Floyd Medical Center, Rome	II	2/81	EMS	State
2	Hamilton Medical Center, Dalton	II	3/3/83	EMS	State
3	Memorial Medical Center, Savannah	I	2/18/81	EMS	Region
4	Medical College of Georgia, Augusta	I	7/1/81	EMS	Region
5	Talmadge Memorial Hospital, Augusta	I	10/1/81	EMS	Region
<u>IDAHO</u>					
1	Eastern Idaho Regional Medical Center, Idaho Falls	II	12/22/86	NHTSA	
2	Kootenai Medical center, Coer d'Alene	III	'79or'80	NHTSA	State
3	Magic Valley Regional Medical Center, Twin Falls	III	'82	NHTSA	State
4	Pocatello Regional Medical Center, Pocatello	II		NHTSA	
5	St. Alphonsus Hospital	II	8/12/75	NHTSA	State
6	St. Joseph's Hospital, Lewiston	III	'82	NHTSA	State
7	Valley Medical Center, Caldwell	III		NHTSA	
<u>ILLINOIS*</u>					
1	Abraham Lincoln Memorial Hospital, Lincoln	III	12/21/71	EMS	State
2	Blessing Hospital, Quincy	II	7/18/78	EMS	State
3	Burnham City Hospital, Champaign	I	10/12/72	EMS	State
4	Children's Memorial Hospital, Chicago	I	11/21/86	EMS	City
5	Christ Community Hospital, Oak Lawn	I	5/20/86	EMS	Metro Comm. of Chicago
6	Community General Hospital, Sterling	III	'73	EMS	State
7	Cook County Hospital, Chicago	I	5/20/86	EMS	City
8	Decatur Memorial Hospital, Decatur	II	10/31/72	EMS	
9	DeKalb Public Hospital, DeKalb	III		EMS	
10	Evanston Hospital, Evanston	I	9/11/71	EMS	State
11	Foster G. McGraw Hospital of Loyola University, Maywood	I	'73	EMS	State

*For Illinois, we have used these equivalents:

Regional Center = Level I
 Areawide Center = Level II
 Local = Level III

NO.	NAME	LEVEL	DATE OF DESIGNATION	SOURCE	DESIGNATED BY
	<u>ILLINOIS</u> , continued				
12	Freeport Memorial Hospital, Freeport	III	9/18/72	EMS	State
13	Good Samaritan Hospital, Mt. Vernon	II	7/25/72	EMS	State
14	Graham Hospital Association, Canton	III	2/21/73	EMS	State
15	Harrisburg Medical Center, Harrisburg	III	5/12/75	EMS	State
16	Illinois Masonic Medical Center, Chicago	I	5/20/86	EMS	Dept. of Health
17	Illinois Valley Community Hospital, Peru	III	1/19/79	EMS	State
18	Kishwaukee Community Hospital, DeKalb	II	12/22/75	EMS	State
19	Louis A. Weiss Memorial Hospital, Chicago	I	5/20/86	EMS	City of Chicago
20	Loyola University Medical Center, Chicago	I	6/86	EMS	City of Chicago
21	Lutheran General Hospital	I	5/20/86	EMS	City of Chicago
22	McDonough County District Hospital, Macomb	III	1/30/73	EMS	State
23	McHenry Hospital, McHenry	III	10/72	EMS	State
24	Memorial District Hospital of Coles County, Mattoon	III		EMS	
25	Memorial Hospital, Belleville	II	6/74	EMS	County
26	Memorial Hospital of Carbondale, Carbondale	I		EMS	
27	Memorial Hospital of DuPage County, Elmhurst	II	2/15/73	EMS	State
28	Mercy Center for Health Care Services, Aurora	II	7/74	EMS	State
29	Michael Reese Hospital and Medical Center, Chicago	I	5/20/86	EMS	City of Chicago
30	Moline Public Hospital, Moline	II	5/72	EMS	State
31	Northwest Community Hospital, Arlington Heights	I	7/31/73	EMS	
32	Northwestern Memorial Hospital-Wesley Pavilion, Chicago	I	1976	EMS	
33	Paris Community Hospital, Paris	III	9/5/72	EMS	State
34	Passavant Memorial Area Hospital, Jacksonville	III		EMS	
35	Pinckneyville Community Hospital, Pinckneyville	III	7/25/75	EMS	State
36	Resurrection Hospital, Chicago	II	7/25/73	EMS	State
37	Richland Memorial Hospital, Olney	III	1/26/73	EMS	State
38	Sarah Bush Lincoln Health Center, Mattoon	III	5/17/77	EMS	State
39	Sherman Hospital, Elgin	II	11/73	EMS	State
40	Southern Medical Center, Cairo	III		EMS	

NO.	NAME	LEVEL	DATE OF DESIGNATION	SOURCE	DESIGNATED BY
	<u>ILLINOIS</u> , continued				
41	St. Anthony Hospital Medical Center, Rockford	I	12/71	EMS	State
42	St. Anthony's Memorial Hospital, Effingham	III	2/20/73	EMS	State
43	St. Elizabeth Hospital, Danville	II	6/1/73	EMS	
44	St. Elizabeth Medical Center, Granite City	II	1/71	EMS	State
45	St. Francis Hospital, Litchfield	III		EMS	
46	St. Francis Hospital Medical Center, Peoria	I	7/71	EMS	State
47	St. James Hospital, Chicago Heights	II	1/74	EMS	State
48	St. James Hospital, Pontiac	III	'71	EMS	State
49	St. John's Hospital, Springfield	I	7/27/71	EMS	State
50	St. Joseph Hospital, Joliet	II	2/15/73	EMS	
51	St. Joseph's Hospital Medical Center, Bloomington	II	9/1/72	EMS	State
52	St. Mary's Hospital Cairo	III		EMS	
53	St. Mary's Hospital, East St. Louis	III	'71	EMS	
54	St. Mary's Hospital, Galesburg	II	1/30/73	EMS	State
55	St. Mary's Hospital, Kankakee	II	11/1/72	EMS	State
56	St. Mary's Hospital, La Salle	III		EMS	
57	St. Therese Hospital, Waukegan	II	2/14/73	EMS	State
58	University of Chicago Med. Center (Billings Hosp.), Chicago	I	Spring '86	EMS	City of Chicago
59	Wood River Township Hospital, Wood River	III	10/73	EMS	State
	<u>INDIANA</u>				
1	Indiana University Hospitals, Indianapolis	III	Fall '86	EMS	
2	Methodist Hospital of Indianapolis, Indianapolis	III	6/79	EMS	Region
	<u>IOWA</u>				
1	Central Iowa Methodist Medical Center, Des Moines	II	10/3/81	EMS	Region
2	Northeast-Schoitz Hospital, Waterloo	II	7/1/81	EMS	Region
3	Sioux Lakes-Marian Health Center, Sioux City	II	Spring '81	EMS	State
	<u>MARYLAND</u>				
1	Francis Scott Key Medical Center, Baltimore	II	12/78	EMS	State
2	Johns Hopkins Hospital, Baltimore	I	'81	EMS	State

NO.	NAME	LEVEL	DATE OF DESIGNATION	SOURCE	DESIGNATED BY
	<u>MARYLAND</u> , continued				
3	Maryland Institute for Emergency Medical Services Systems	Shock Trauma		EMS	
4	Memorial Hospital of Cumberland, Cumberland	II	1/5/81	EMS	State
5	Peninsula General Hospital Medical Center, Salisbury	II	2/22/78	EMS	
6	Prince George's General Hosp. and Med. Center, Cheverly	II		EMS	
7	Sinai Hospital, Baltimore	II		EMS	
8	Suburban Hospital of Bethesda, Bethesda	II	5/14/74	EMS	State
9	University of Maryland Hospital, Baltimore	I		EMS	
10	Washington County Hospital	II	1/80	EMS	
	<u>MASSACHUSETTS</u>				
1	Bay State Medical Center, Springfield	I	12/84 (prov.)	NHTSA	Region
2	Berkshire Medical Center, Pittsfield	II	12/84 (prov.)	NHTSA	Region
3	Boston Emergency Medical Center, Boston	I	'80	NHTSA	Region
4	Lawrence General Hospital, Lawrence	II	10/2/81	NHTSA	Region
5	Longwood Area Trauma Center, Boston	I	'80	NHTSA	Region
6	Lowell General Hospital, Lowell	II	8/26/82	NHTSA	Region
7	Lynn Hospital, Lynn	II	8/12/80	NHTSA	Region
8	Massachusetts General Hospital, Boston	I	'80	NHTSA	Region
9	University of Massachusetts Medical Center, Worcester	I	3/80	NHTSA	Region
	<u>MISSOURI</u>				
1	Audrain Medical Center, Mexico	III	5/5/81	EMS	State
2	Aurora Community Hospital, Aurora	III	6/5/86	EMS	State
3	Baptist Memorial Hospital, Kansas City	II	8/81	EMS	State
4	Barnes Hospital, St. Louis	I	'81	EMS	State
5	Boone Hospital Center, Columbia	II	'81	EMS	State
6	Cardinal Glennon Children's Hospital, St. Louis	I	11/6/81	EMS	State
7	Charles E. Still Osteopathic Hospital, Jefferson City	II	'81	EMS	State
8	Children's Mercy Hospital, Kansas City	I	'81	EMS	State
9	Christian Hospital Northeast, St. Louis	II	6/84	EMS	State
10	DePaul Community Health Center, Bridgeton	II	6/30/81	EMS	State
11	Doctor's Regional Medical Center, Poplar Bluff	II	11/81	EMS	State

NO.	NAME	LEVEL	DATE OF DESIGNATION	SOURCE	DESIGNATED BY
	<u>MISSOURI</u> , continued				
12	Freeman Hospital, Joplin	II	10/81	EMS	State
13	Golden Valley Memorial Hospital, Clinton	II	11/6/81	EMS	State
14	Jefferson Memorial Hospital, Festus	III	1/81	EMS	State
15	John Fitzgibbon Memorial Hospital, Marshall	III	Spring '81	EMS	State
16	Independence Sanitarium and Hospital, Independence	II	7/81	EMS	State
17	Kirksville Osteopathic Hospital Unit, Kirksville	II	9/79	EMS	State
18	Lake of the Ozarks General Hospital, Osage Beach	II	7/14/81	EMS	State
19	Lester E. Cox Medical Center, Springfield	II	9/15/86	EMS	State
20	Levering Hospital, Hannibal	III	4/83	EMS	State
21	Liberty Hospital, Liberty	II	'81	EMS	State
22	Lincoln County Memorial Hospital, Troy	III	11/6/81	EMS	State
23	Lucy Lee Hospital, Poplar Bluff	III	9/9/81	EMS	State
24	Medical Center of Independence, Independence	II	2/16/81	EMS	State
25	Memorial Community Hospital, Jefferson City	II	9/84	EMS	State
26	Menorah Medical Center, Kansas City	II	Summer '80	EMS	State
27	Methodist Medical Center, St. Joseph	II	9/84	EMS	State
28	Mineral Area Osteopathic Hospital, Farmington	III	12/17/81	EMS	State
29	Missouri Delta Community Hospital, Sikeston	II	9/81	EMS	State
30	Moberly Regional Medical Center, Moberly	III	1/15/85	EMS	State
31	Normandy Osteopathic Hospital, North Normandy	II	11/6/81	EMS	State
32	North Kansas City Memorial Hospital, Kansas City	II	11/6/81	EMS	State
33	Oak Hill Hospital, Joplin	III	6/81	EMS	State
34	Park Lane Medical Center, Kansas City	III	9/84	EMS	State
35	Phelps County Regional Medical Center, Rolla	II	1/84	EMS	State
36	Research Medical Center, Kansas City	II	'81	EMS	State
37	St. Anthony's Medical Center, St. Louis	II	'81	EMS	State
38	St. Elizabeth Hospital, Hannibal	III	'81	EMS	State
39	St. Francis Hospital, Maryville	III	3/24/82	EMS	State
40	St. Francis Medical Center, Cape Girardeau	II	Summer '82	EMS	State
41	St. John's Medical Center, Joplin	II	11/6/81	EMS	State
42	St. John's Mercy Medical Center, St. Louis	II	10/86	EMS	State
43	St. John's Regional Health Center, Springfield	II	'81	EMS	State
44	St. Joseph Hospital, Kansas City	II	9/81	EMS	State

NO.	NAME	LEVEL	DATE OF DESIGNATION	SOURCE	DESIGNATED BY
	<u>MISSOURI</u> , continued				
45	St. Joseph Hospital, Kirkwood	II	'81	EMS	State
46	St. Joseph Hospital, St. Charles	II	Summer '81	EMS	State
47	St. Joseph Hospital (Heartland East), St. Joseph	II	8/80	EMS	State
48	St. Louis Children's Hospital, St. Louis	I		EMS	
49	St. Louis University Hospital, St. Louis	I	'81	EMS	State
50	St. Luke's Hospital, Kansas City	I	9/7/82	EMS	State
51	St. Mary's Health Center, Jefferson City	II	5/81	EMS	State
52	St. Mary's Hospital, Kansas City	II	8/86	EMS	State
53	Skaggs Community Hospital, Branson	III	'81	EMS	State
54	Southeast Missouri Hospital, Cape Girardeau	II		EMS	
55	Texas County Memorial Hospital, Houston	III	9/10/84	EMS	State
56	Trinity Lutheran Hospital, Kansas City (not designated yet)	II		EMS	
57	Truman Medical Center, Kansas City	I	11/6/81	EMS	State
58	University Hospital, Kansas City	II	8/81	EMS	State
59	University of Missouri Hospital and Clinics, Columbia	I	5/81	EMS	State
60	West Plains Memorial Hospital, West Plains	III	Summer '81	EMS	State
	<u>NEBRASKA</u>				
1	Great Plains Medical Center, North Platte	II		NHTSA	
2	Lincoln General Hospital, Lincoln County	II	'81	NHTSA	State
3	Mary Lanning Hospital, Hastings	II	4/81	NHTSA	State
4	St. Joseph Hospital, Omaha	I	6/82	NHTSA	State
5	University of Nebraska Medical Center, Omaha	I	'80	NHTSA	County
	<u>NEW HAMPSHIRE</u>				
1	Androscoggin Valley Hospital, Berlin	III	6/3/82	EMS	State
2	Cheshire Hospital, Keene	III	6/1/81	EMS	State
3	Concord Hospital, Concord	II	11/18/81	EMS	State
4	Elliot Hospital, Manchester	II	3/81	EMS	State
5	Exeter Hospital, Exeter	III	1/5/81	EMS	Region
6	Lakes Region General Hospital, Laconia	III	11/19/81	EMS	State
7	St. Joseph Hospital, Nashua	II	6/81	EMS	Region
8	Wentworth-Douglas Hospital, Dover	II	12/82	EMS	State

NO.	NAME	LEVEL	DATE OF DESIGNATION	SOURCE	DESIGNATED BY
<u>NEW MEXICO</u>					
1	Lovelace Medical Center, Albuquerque	II	9/84	EMS	State
2	Presbyterian Hospital Center, Albuquerque	II	3/82	EMS	State
3	St. Joseph Hospital, Albuquerque	II	5/84	EMS	State
4	St. Mary's Hospital, Roswell	III	7/27/84	EMS	State
5	St. Vincent's Hospital, Santa Fe	II	10/18/84	EMS	State
6	St. San Juan Regional Medical Center, Farmington	II	6/29/83	EMS	State
7	University of New Mexico Hospital, Albuquerque	I	11/30/83	EMS	State
<u>NEW YORK</u>					
1	Albany Medical Center Hospital, Albany		3/1/82	EMS	Region
2	Bellevue Hospital Center, Manhattan		7/26/83	EMS	NY City
3	Booth Memorial Medical Center, Queens		9/22/83	EMS	NY City
4	Brookdale Hospital Medical Center, Brooklyn		12/12/83	EMS	NY City
5	City Hospital Center at Elmhurst, Queens		6/82	EMS	NY City
6	Harlem Hospital Center, Manhattan		8/1/83	EMS	NY City
7	Kings County Hospital Center, Brooklyn		9/82	EMS	NY City
8	Lincoln Hospital, Bronx		7/1/82	EMS	NY City
9	Rochester General Hospital, Rochester			EMS	Self
10	St. Luke's-Roosevelt Hospital Center, Manhattan		8/83	EMS	NY City
11	St. Vincent's Hospital Medical Center, Manhattan		7/83	EMS	NY City
12	Westchester County Medical Center, Valhalla		8/85	EMS	Hudson Valley Reg EMS
<u>NORTH CAROLINA</u>					
1	Duke University Medical Center, Durham	I	'82	EMS	State
2	Moses H. Cone Memorial Hospital, Greensboro	II	11/30/84	EMS	State
3	North Carolina Baptist Hospitals, Inc., Winston-Salem	I	11/15/82	EMS	State
4	North Carolina Memorial Hospital, Chapel Hill	I	'81	EMS	State
5	Pitt County Memorial Hospital, Greenville	I	12/10/85	EMS	State
<u>NORTH DAKOTA</u>					
1	Medcenter One, Bismark	II	2/86	EMS	State
2	St. Luke's Hospitals, Fargo	II	9/23/85	EMS	Organiz'n of Minn.

NO.	NAME	LEVEL	DATE OF DESIGNATION	SOURCE	DESIGNATED BY
<u>PENNSYLVANIA</u>					
1	Allegheny General Hospital, Pittsburgh	I	10/86	PTSF*	PTSF
2	Children's Hospital, Philadelphia (pediatric)	I	10/86	PTSF	PTSF
3	Children's Hospital of Pittsburgh	I	12/86	PTSF	PTSF
4	Crozer-Chester Medical Center, Chester	I	12/86	PTSF	PTSF
5	Frankford Hospital, Philadelphia	II	10/86	PTSF	PTSF
6	Geisinger Medical Center, Danville	I	10/86	PTSF	PTSF
7	Hahnemann University, Philadelphia	I	10/86	PTSF	PTSF
8	Lehigh Valley Hospital Center, Allentown	I	10/86	PTSF	PTSF
9	Milton S. Hershey Medical Center, Hershey	II	10/86	PTSF	PTSF
10	Robert Packer Hospital, Sayre	II	10/86	PTSF	PTSF
11	Presbyterian University Hospital, Pittsburgh	I	12/86	PTSF	PTSF
12	York Hospital, York	I	10/86	PTSF	PTSF
<u>RHODE ISLAND</u>					
1	Rhode Island Hospital, Providence	I	2/26/80	EMS	State
<u>SOUTH CAROLINA</u>					
1	Greenville Memorial Hospital, Greenville	I	4/3/80	EMS	State
2	Medical University Hospital, Charleston	I	4/80	EMS	State
3	Richland Memorial Hospital, Columbia	I	8/30/81	EMS	Region
4	Spartanburg General Hospital, Spartanburg	I	7/1/85	EMS	State
<u>TENNESSEE</u>					
1	Bristol Memorial Hospital, Bristol (not designated yet)	II		NHTSA	
2	Elvis Presley Trauma Center; The Regional Medical Center	I	'87	NHTSA	State
3	at Memphis, Memphis				
4	Enlanger Medical Center, Chattanooga	I	'87	NHTSA	State
5	Holston Valley Hospital and Medical Center, Kingston	II	'87	NHTSA	State
6	Jackson-Madison County General Hospital, Jackson (not designated yet)	II		NHTSA	
7	University of Tennessee Memorial Hospital, Knoxville	I	'87	NHTSA	State
8	Vanderbilt University Hospital, Nashville	I	'87	NHTSA	State

*Pennsylvania Trauma Systems Foundation

NO.	NAME	LEVEL	DATE OF DESIGNATION	SOURCE	DESIGNATED BY
	<u>TEXAS</u>				
1	Ben Taub Hospital, Houston	I	10/19/84	EMS	State
2	Good Shepherd Medical Center, Longview	II	2/1/86	EMS	Dept. of Health
3	Hermann Hospital, Houston	I	9/25/85	EMS	State
4	Parkland Hospital, Dallas	I	8/15/83	EMS	State
5	R.E. Thomason Hospital, El Paso	I	9/86	EMS	State
	<u>UTAH</u>				
1	Cottonwood Hospital Medical Center, Murray	II	4/11/84	EMS	State
2	Holy Cross Hospital, Salt Lake City	II	10/83	EMS	State
3	Intermountain Trauma Complex [consortium of LDS Hospital and the University of Utah Health Sciences Center], Salt Lake City	I	6/5/83	EMS	State
4	McKay Dee Medical Center, Ogden	II	12/7/83	EMS	State
5	St. Benedict's Hospital, Ogden	II	11/83	EMS	State
	<u>VIRGINIA</u>				
1	Alexandria Hospital, Alexandria	II	11/24/82	EMS	State
2	Arlington Hospital, Arlington	II	4/11/83	EMS	State
3	Community Hospital of Roanoke Valley, Roanoke	II	4/82	EMS	State
4	Fairfax Hospital, Falls Church	I	4/12/83	EMS	State
5	Hampton General Hospital, Hampton	II	1/12/83	EMS	
6	Mary Immaculate Hospital, Newport News	III	10/1/84	EMS	Virginia Trauma Reg.
7	Medical College of Virginia Hospital, Richmond	I	1/82	EMS	State
8	National Hospital for Orthopaedics and Rehabilitation, Arlington	III	5/85	EMS	State
9	Norfolk General Hospital, Norfolk	I	10/84	EMS	State
10	Riverside Hospital, Newport News	II	5/30/86	EMS	State
11	Roanoke Memorial Hospital, Roanoke	I	9/83	EMS	State
12	University of Virginia Hospital, Charlottesville	I	1/10/83	EMS	State
	<u>WEST VIRGINIA</u>				
1	West Virginia University Hospital, Inc., Morgantown	I	Summer '85	EMS	

ATTACHMENT III

**The Effect of Trauma Designation
on Hospitals**

by

David Kidder, Ph.D.

THE EFFECT OF TRAUMA DESIGNATION ON HOSPITALS

III.1 OVERVIEW

Hospitals with trauma centers are different from other hospitals. They are larger, in staff, bed size and volume of services delivered. They are more likely to be teaching institutions, located in urban areas. They tend to incur higher average costs per day but, because stays are somewhat shorter than in non-trauma hospitals, lower costs per admission.

In this form, statistics about trauma centers tell little about why such differences exist. Trauma hospitals might have been larger and higher in per diem costs before they installed a trauma program. They might have operated in markets that were systematically different, in competitiveness, in the supply of health resources, in critical demographic characteristics, from non-trauma centers' markets. Even if becoming a trauma center does have some effect on volume and costs, the effect may be buried among confounding factors, such as ownership, teaching status, etc. that are equally and perhaps more important determinants of these outcomes.

In order to isolate the "trauma center" contribution, estimates of outcomes have to be adjusted, to remove confounding influences. One way to do this is through multiple linear regression, a statistical technique that allows the investigator to measure the influence of many factors on certain outcomes. The technique produces coefficients for each factor that can be interpreted as the influence of that factor, holding all other measured influences constant. The "net" contribution to any changes in cost, for example, of becoming a trauma center (irrespective of bed size, location and other factors) can thus be captured in one or more coefficients of a regression equation.

The technique used here to detect trauma effects is known as a "four way" evaluation design, because it utilizes contrasts between trauma and non-trauma hospitals and comparisons over time, before and after implementation of the trauma program. For example, before implementation we estimate a cross-sectional contrast for cost per day:

A. Trauma hospitals average cost/day	-	Non-trauma hospitals average cost/day	BEFORE
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After implementation, we have the relation:

B. Trauma hospitals - Non-trauma hospitals AFTER
average cost/day average cost/day

The effect of becoming a trauma center is the difference (B - A). If trauma hospitals were more expensive than non-trauma hospitals before they implemented their programs, and were equally expensive after, then $B - A = 0$: becoming a trauma center had no net effect on cost per day. But if B is larger (or smaller) than A, then, providing that possible confounding influences have been accounted for, it can be asserted that implementing a trauma center is associated with an increase (or decrease) in cost per day.

This report is organized as follows. Data sources and statistical methods are described in Section 2.0. Section 3.0 presents findings on the effects of trauma center implementation on utilization, costs and staffing levels. Section 4.0 discusses the analysis and points out data problems that the reader should keep in mind in evaluating the findings.

III.2 DATA AND METHODOLOGY

Data for this analysis came from three sources:

- A list of U.S. hospitals with designated trauma centers, compiled by Abt Associates from information supplied by the EMS Clearinghouse, the Department of Transportation, and supplemented by AAI telephone interviews; where available, date of implementation, level (according to ACS or other standards) and the designating authority are specified.
- Statistical data on U.S. hospitals from the American Hospital Association's (AHA) Annual Survey for 1980-1985.
- Statistical data on county characteristics from the Area Resource File (ARF) and from special data bases compiled by the U.S. Department of Health and Human Services and U.S. Department of Labor's Bureau of Labor Statistics.

Outcome measures, based entirely on AHA data, are listed in Table 1. Although most are self-explanatory, so-called "adjusted" measures of volume need explanation. The AHA combines both inpatient and outpatient utilization in adjusted patient days (ADJPD) and adjusted admissions (ADJADM). This measure captures total activity of the hospital more completely than separate measures of inpatient days or outpatient visits. It is an "equivalent day" index, computed by adding a factor to total inpatient days that represents the day-equivalent of an outpatient visit, defined as:

$$\frac{\text{Outpatient revenue}}{\text{Inpatient revenue}} \times \text{Inpatient days}$$

Explanatory variables, computed from AHA, ARF and from the AAI trauma center directory, are listed in Table 2. Trauma indicators fall into four categories:

- Trauma center (TR_CENTER), a categorical variable that takes a value of 1 (0 otherwise) for any hospital that was a trauma center at any time in the study period.
- Trauma designation: self-designation (TRSELF) and designated by outside party (TROFF)--it was assumed that trauma centers that had to meet "official" standards might have different characteristics from those that did not.
- Trauma level (TR1, TR2, TR3), identifying the level of medical resources available to provide trauma care;
- Trauma date: two types of measures were constructed and tested separately for trauma center "cohorts," identified by the year the center was implemented.

Table III-1

TRAUMA CENTER ANALYSIS: OUTCOME MEASURES

Category	Variable Name	Definition
<u>Utilization</u>		
	ADJADM	Adjusted admissions
	ADJPD	Adjusted patient days
	ICIPDTOT	Inpatient days/in intensive care
	ICPCT	ICU % of inpatient days
	SUROPAMB	Outpatient surgical operations
	SUROPIP	Inpatient surgical operations
	OPSPCT	# surgeries: outpatient/inpatient
	SUROPTOT	Total surgical operations
	VEM	Emergency outpatient visits
	VTOT	Total outpatient visits
<u>Cost</u>		
	COSTDAY	Cost/day
	COSTADM	Cost/admission
	PAYFTE	Pay rate
<u>Staffing</u>		
	FTE	Full-time equivalent personnel

Table III-2

TRAUMA CENTER ANALYSIS: EXPLANATORY VARIABLES

Category	Variable Name	Definition
<u>Hospital Level Variables</u>		
	BED	Total beds in 1980
	TEACH	If = 1, hosp. has teaching status
	PROP	Proprietary ownership
	GOV	Non-federal govt. control
	URBAN	Hosp. is in urban county
	URBED	Beds for urban hosp.
<u>Area Level Variables</u>		
	AFDCPCT	% of population on AFDC
	BIRTH	Births per 100K population
	CAPINC	Mean per capita income
	EDUC	Median school years completed in 1970
	HERFINDX	Herfindahl index (a measure of competition)
	HMOPOP	% of pop. enr. in HMO (SMSA or county)
	NHBPOP	Nursing home beds per 100K population
	P	Population
	POPDENS	Population per square mile
	POPT18P	% of population on Part A Medicare
	SPMDPCT	% of pat. care drs. who are specialists
	WHITEPCT	% of population that is white
	MCAIDIPD	Total Medicaid inpatient days

Table III-2
(continued)

Category	Variable Name	Definition
<u>Trauma Center Variables</u>		
	TR_CNTR	If = 1, provider is a Trauma Center
	TR1	If = 1, trauma level = 1, else = 0
	TR2	If = 1, trauma level = 2, else = 0
	TR3	If = 1, trauma level = 3, else = 0
	TRAUMA80	1 in 80 and all subsequent years
	TRAUMA81	1 in 81 and all subsequent years
	TRAUMA82	1 in 82 and all subsequent years
	TRAUMA83	1 in 83 and all subsequent years
	TRAUMA84	1 in 84 and all subsequent years
	TRAUMA85	1 in 85 and all subsequent years
	TRMA_80	1 in 80, 0 for all other years
	TRMA_81	1 in 81, 0 for all other years
	TRMA_82	1 in 82, 0 for all other years
	TRMA_83	1 in 83, 0 for all other years
	TRMA_84	1 in 84, 0 for all other years
	TRMA_85	1 in 85, 0 for all other years
	TROFF	If = 1, state, cnty., EMS reg., city, etc., else = 0
	TRSELF	If = 1, self designation, else = 0
<u>Other Variables</u>		
	IL	If = 1, provider in Illinois, else = 0
	MS	If = 1, provider in Missouri, else = 0
	T2	Year = 1981
	T3	Year = 1982
	T4	Year = 1983
	T5	Year = 1984
	T6	Year = 1985

- TRAUMA() equals 1 in the year a trauma center was implemented and all years thereafter;
- TRMA_() equals 1 in the year of implementation, and 0 afterward.

TRAUMA() captures a shift in an outcome averaged over all the years after implementation (through 1985). TRMA_() captures only the first year effect. Thus, TRAUMA(82) would measure the net change from the 1980-81 period (before) to the 1982-1985 period (after). TRMA_82, on the other hand, picks up only the net first year change (from 1980-81, to 1982).

In the design constructed for this study, the size and significance of the coefficient of TRAUMA() generally provides the clearest indication of whether or not implementing a trauma center is associated with a changed outcome. The validity of this measure is probably greater for hospitals that started trauma units in the early years of the period (1980-82) because there are a sufficient number of "after" years for these hospitals to indicate whether any first year effects are reversed as time passes or, alternatively, whether effects are delayed after the first year. We show outcomes and effects calculated for all five years, however, because the pace of implementation accelerated over the period, and therefore findings for more recent participants are of interest.

Two variables were added to certain estimates, to indicate hospitals operating in Illinois (IL) and Missouri (MS). Since a large number of hospitals in these states (60 in Missouri and 59 in Illinois) have been designated trauma centers, it was decided that measures of trauma effects would be adjusted, to take account of the possible distorting influence of these two states' data. They constitute over a third of the number of trauma centers. Estimates were also made excluding all Illinois and Missouri hospitals. In general, conclusions drawn from these analyses were not changed by the presence or absence of these states.

Multivariate analyses were conducted on a sample of over 6,000 U.S. hospitals that reported to the AHA in any year, from 1980 through 1985. The actual number of hospitals in any year varied, both because hospitals entered (or left) the industry, and because some hospitals failed to report certain data.

III.3 FINDINGS

Findings of the multivariate analyses can be briefly summarized in the following manner:

Utilization effects

- Trauma center hospitals are larger on average than non-trauma hospitals. However, implementing the center does not always produce these differences.
 - In the first year of implementation, adjusted admissions and days are generally higher (by 850 to 1,700 admissions per year, and 3,500 to 7,400 days per year) than similar non-trauma hospitals. Later events tend to mitigate, and sometimes reverse, these effects. Some cohorts actually show reduced admissions and days over a two to five year period after implementation.
 - Outpatient surgeries tend to fall during the first year of implementation, whereas inpatient surgeries rise or stay the same. In general, these trends are reversed for outpatient surgery over longer post-implementation periods. Inpatient surgical procedures, over the longer period, tend to be higher in trauma hospitals, but the difference is not large enough to be statistically significant.
 - Outpatient visits rise dramatically in the first year (an effect ranging from 3,900 to 38,700 visits per year). Once again, factors in succeeding years often reduce or reverse this effect.
 - ICU days (total, and as a percentage of inpatient days) drop in the first year, from 780 to 1,800 days per year. This pattern is maintained, but the effect reduced, for ICU utilization over the whole post-implementation period.
 - There are no statistically significant associations between trauma center implementation and the ratio of outpatient to inpatient surgical procedures, although the sign of the various coefficients suggests a slight negative impact.

Cost and staffing effects

- Cost per admission is lower, and cost per inpatient day is higher in the average trauma center. However, the impact of trauma center implementation on cost per admission is unclear: the largest initial effects are negative, but longer run effects vary from positive to negative. Effects on cost per day tend to be negative, which means that these hospitals' above-average per diem costs follow a downward trend.
- The average trauma center's annual pay rate is \$1,134 higher than a similar non-trauma center's. First year effects tend to be

strongly negative, because the number of total full time equivalent employees increases rapidly in the first year (increases of up to 250 FTEs). Later on, the changes in skill mix and other factors apparently raise the pay rate differential higher for some trauma centers.

Special hospitals

- There are virtually no differences in utilization, costs and staffing levels between trauma and non-trauma centers that are also teaching hospitals. However, trauma/non-trauma differences for large hospitals (over 250 beds) tend to be large and significant. For both subgroups, the implementation of a trauma center has about the same relative effects on outcomes as in the more general analyses.

Two general comments are also in order:

- The estimated effects of implementing a trauma center often differ widely among cohorts. These differences could be due to hospital characteristics of the cohorts. For example, hospitals that installed trauma centers in 1984 could be systematically different, in size, service composition, ownership, and other factors, from the 1982 cohort. Discovering what these differences are, and which of them are important determinants of cohort-specific outcomes is time-consuming and beyond the scope of this report.
- Post-implementation trends in utilization and cost outcomes generally reduce pre-existing gaps between trauma and non-trauma hospitals; trauma hospitals become "smaller" in in-patient and out-patient volume, and "less costly," on a per diem basis relative to the average. However, these trends do not entirely reverse any pre-implementation differences. Trauma hospitals are larger and more costly than the average before and after development of their trauma units.

The findings in this section are based on regression estimates. The actual regressions can be found in Appendix C (not included in this volume), along with statistics that allow the reader to evaluate the explanatory power of each regression. As noted earlier, trauma center effects are measured using estimated coefficients from the regressions. The statistical significance of each coefficient is noted, but the reader should understand that characteristics of the data may generate "significant" outcomes that make no intuitive sense (see Section 4.0). We also report the size and signs of coefficients that do not meet any of the standard tests for significance. Sometimes a pattern in the signs provides insights into associations among variables, even though technically we cannot reject the hypothesis that there are no effects.

Trauma Implementation and Hospital Utilization

It is reasonable to predict that a hospital that sets up a trauma unit will experience a change in casemix, both in ambulatory and inpatient admissions, and a shift toward relatively more surgery, to meet the needs of trauma patients. This "primary utilization effect" may be accompanied by a secondary effect; installing the unit generates an overall increase in demand for the hospital's services, because potential users in the hospital's market area see the trauma unit as an indicator that the overall quality and comprehensiveness of services at the hospital has increased. If prices that patients have to pay for care rise in the trauma hospital, to cover increased costs, then we would expect to see demand creation tempered by budget considerations. However, because insurance coverage of and public sector reimbursement for hospital care is extensive, most potential users are relatively insensitive to the direct costs of hospital services. In fact, a trauma center may reduce perceived indirect costs of care, by increasing the speed of response to emergencies and thereby reducing the effective distance between victim and service provider. Therefore, we hypothesize that both primary and secondary effects on total in-patient and out-patient utilization will be positive.

Total hospital utilization generally does increase in the first year a trauma service is provided, but that increase may not be sustained. As Table 3 shows, the average trauma hospital admits 4,749 more ambulatory and inpatient users each year and provides 7,660 more adjusted days than comparable hospitals that do not become trauma centers, and changes during the first year of implementation generally widen the gap even further. For example, hospitals that opened a trauma unit in 1981 admitted an average of 849 individuals in that year and provided 3,586 more adjusted days. But over the period 1981 to 1985 average adjusted admissions for these hospitals were 906 lower than the trauma hospital average; adjusted days were also reduced. Similar results are evident in other years. In some cases, such as 1982 trauma hospitals, the average utilization effect is positive both in the implementation year and over the whole post-enrollment period (1,755 and 345 adjusted admissions; 6,244 and 1,807 adjusted days, respectively). But the lack of statistical significance in the "full post-implementation period" coefficients indicates that these hospitals no longer differ significantly from other trauma hospitals once the initial impact has dissipated.

Outpatient surgical procedures tend to decline or stay unchanged in the first year, while inpatient surgical procedures increase. Most of the early outpatient surgical effects are reversed: for example, hospitals that developed trauma services in

Table III-3

UTILIZATION EFFECTS OF TRAUMA CENTER IMPLEMENTATION¹

	Average ²	Implementation Dates					
		1980	1981	1982	1983	1984	1985
Adjusted admissions	4749 ^a	-945 ^b -96	-906 ^b 849 ^b	345 1755 ^a	19 1410 ^a	138 1390 ^a	1252 ^a ---
Adjusted patient days	7660 ^a	3768 ^c 7354 ^a	-2659 3586 ^b	1807 6244 ^a	-664 4437 ^b	5024 ^a 5101 ^a	77 ---
Outpatient surgical procedures	370 ^a	104 -482 ^a	11 -586 ^a	-650 ^a -597 ^b	123 53	382 ^a -70	-452 ^a ---
Inpatient surgical procedures	1133 ^a	302 548 ^a	245 240	-302 0.94	273 302 ^c	133 28	-105 ---
Total surgical procedures	1503 ^a	406 67	257 -339	-951 ^a -596 ^b	396 355	515 ^b -41	-556 ^b
Emergency visits	16215 ^a	-3880 ^a -3539 ^b	-8964 ^a 340	8668 ^a 9305 ^a	-239 637	1214 876	-338 ---
Total outpatient visits	66783 ^a	-628 16781 ^a	-21243 ^a 17490 ^a	34756 ^a 38652 ^a	-2822 3896	19458 ^a 6718	-12740 ^a ---
ICU days	3225 ^a	-871 ^b -1811 ^a	339 -940 ^a	-470 -1279 ^a	347 -782 ^b	-4223 ^a -1130 ^a	3094 ^a ---
ICU as % of total inpatient days	0.020 ^a	0.005 -0.002	0.008 -0.007 ^c	-0.016 ^a -0.015 ^a	0.021 ^a 0.001	-0.034 ^a -0.019 ^c	0.015 ^a ---
Outpatient/in-patient surgeries	-0.009	-0.037 -0.180	-0.073 -0.143	-0.063 -0.070	0.041 -0.008	-0.027 -0.049	-0.021 ---

¹For each variable, the first line shows the effect averaged over all years after implementation: i.e., TRAUMA(); the second line shows the effect for the implementation year: TRMA_().

²Average over all years and cohorts.

^aSignificance < 0.01

^b0.01 ≤ Significance < 0.05

^c0.05 ≤ Significance < 0.10

1980 provide an average of 104 more outpatient procedures for the period 1981 to 1985, after a first year drop of 482 procedures. For 1982 trauma hospitals, the decline continues and the gap widens, although this cohort seems to be an exception. It is somewhat an exception in inpatient surgery as well, showing nearly no first year response and a (statistically insignificant) decrease in inpatient surgery over the whole post-implementation period. Combining both inpatient and outpatient surgery, the 1982 cohort shows strong negative trends after implementation, relative to other trauma hospitals, an anomalous result when the mixed signs and generally insignificant estimates for the other cohorts are considered.

Trauma units are associated with above average total outpatient utilization; however, with the exception of the 1984 trauma cohort, these effects grow smaller over time. The average trauma hospital provides more outpatient services before and after implementation. In the implementation year, the estimated increases above this average range from 3,896 visits (for 1983) to 38,652 visits (for 1982). Over the period 1983-85, the (statistically insignificant) positive trauma effect is reversed, to an insignificant decrease. For example, the 1982 cohort shows an above-average but slightly smaller effect over the long run (34,756 visits).

The evidence on trauma and emergency visits is not at all clear. Directions, sizes and levels of significance of estimated effects vary widely from cohort to cohort. Past experience with AHA data has shown that hospitals report emergency room utilization inconsistently over time. Unfortunately, we have no way of cleaning these data, to reject obviously erroneous reports and base estimates on consistent information.

Somewhat unexpectedly, implementation of a trauma center seemed to reduce intensive care (ICU) days, both the number and share in total inpatient days. Because trauma hospitals are larger than other hospitals, they provide more ICU days (3,225 per year); as complex, teaching-oriented institutions, they also tend to attract a patient mix with above average ICU requirements (with an ICU/total day ratio 0.020 percentage points above the average). But the implementation year is always associated with a relative decline in ICU days; the ICU share of total days also falls in three of five cohorts. As with other indicators, once the trauma unit is in place, forces operate to check this decline for most cohorts. However, 1982 and 1984 trauma hospitals experience an accelerating decline in the ICU share of total days over the post-implementation period (-0.016 and -0.034 percentage points, respectively). For 1984 trauma hospitals, much of this effect results from absolute decreases in ICU days

(an average of -4,223 days per year from 1984 to 1985). Among 1982 trauma hospitals, the estimated decline in ICU days is smaller, and insignificantly different from zero, suggesting that total and ICU days changed little between 1982 and 1985.

Trauma Center Effects on Hospital Costs and Staffing Levels

Unless a trauma center substitutes for some other complex, labor-intensive service, we expect that hospital costs should increase after the unit is developed. Costs per adjusted admission and per day will depend upon the effect of the unit on patient casemix and on patterns of practice. If the center attracts a complex casemix, then length of inpatient stay might increase. However, if more cases are handled in an outpatient setting, or if cases admitted from the trauma unit to the hospital are treated surgically and discharged to sub-acute care settings for rehabilitation and recovery, the hospital's average length of stay might decline. If the average stay declines and/or the complexity of casemix increases, cost per adjusted day should increase; however, cost per adjusted admission will either increase (if total cost increases are large, or if the number of cases admitted drops) or decrease (if the rate of increase in admissions is greater than the rate of increase in daily costs).

We expect that payroll increases should be a large part of any cost consequence of installing a trauma unit. However, if initial staffing needs are great, the average pay of each full-time equivalent (FTE) staff member may actually fall. Over the longer run, however, pay rates in trauma center hospitals should increase relative to the average, as highly skilled physician, nursing and technical staff are recruited.

As Table 4 demonstrates, the cost implications of establishing a trauma unit are not at all obvious. Trauma hospitals tend to have lower costs per adjusted admission and higher costs per adjusted day than the average, reflecting shorter average inpatient stays (and more of both them and outpatient visits), combined with relatively resource-intensive service delivery. The first year effects of a trauma unit on cost per day is generally negative, but seldom large or statistically significant. Longer run effects are represented by a confused mix of signs and values, both for per day and for per admissions costs.

As predicted, pay rates, which average \$1,134 higher per year in trauma center hospitals, decline in the first year of implementation, followed by a recovery for most cohorts. Average declines vary from \$756 to \$1,637. For most hospitals, initial staffing needs appear to be the force reducing average pay rates. How much of these

Table III-4
COST AND STAFFING EFFECTS OF TRAUMA CENTER IMPLEMENTATION¹

	Average ²	Implementation Dates					
		1980	1981	1982	1983	1984	1985
Cost/admission	-10515 ^a	1628	6459 ^b	-9150 ^a	1406	51	-95
		298	-1330	-7788 ^a	1362	-44	---
Cost/day	85 ^a	31	-13	43 ^b	-36 ^b	-28 ^c	19
		16	-15	-2	-46 ^a	-9	---
Payroll/full time equivalent staff	1134 ^a	898 ^b	213	669	-692 ^b	-956 ^a	12
		142	-756 ^a	-968 ^a	-1637 ^a	-944 ^a	---
Full time equivalent staff	333 ^a	105 ^a	-88 ^a	236 ^a	-123 ^a	12	109 ^a
		248 ^a	143 ^a	231 ^a	-4	122 ^a	---

¹For each variable, the first line shows the effect averaged over all years after implementation: TRAUMA(); the second line shows the effect for the implementation year TRMA_ ().

²Average over all years and cohorts.

^aSignificance < 0.01

^b0.01 ≤ Significance < 0.05

^c0.05 ≤ Significance < 0.10

are associated with the unit itself and how much with derived utilization cannot be determined. But work forces underwent increases of 122 to 248 FTEs. Such increases apparently exceed the rate of pay inflation in trauma hospitals, and initially narrow the trauma-nontrauma hospital pay rate differential.

Trauma Center Effects on Special Hospitals: Teaching Institutions and Hospitals with Over 250 Beds

So far, the findings of multivariate analyses have suggested that trauma hospitals are different from other hospitals in many ways, but that those differences cannot easily be attributed to the development of a trauma service. These fundamental differences themselves seemed to us potential sources of confusion in the estimates. By comparing all, or almost all, U.S. hospitals, we run the risk of overloading the statistical tools that are being used to control for confounding effects. A three-bed hospital in rural Montana will never be a candidate for a trauma unit, and "comparisons" between it (and others like it) and larger urban trauma center hospitals are virtually meaningless.

To alleviate this problem, regressions were rerun on samples of hospitals more nearly alike in general characteristics. We report here on two such analyses: (1) trauma and nontrauma hospitals with 250 or more beds ("large" hospitals); and (2) trauma and nontrauma teaching hospitals.¹

Regressions run on these two samples are included in Appendix D (not included in this volume). They lead to the following generalizations:

- Teaching hospitals with and without trauma units are quite similar in levels of utilization, costs and staffing. In most regressions, the overall trauma indicator was small and statistically insignificant.
- The same cannot be said for large hospitals. For this group, trauma indicators sometimes, as in the case of adjusted patient days, suggest a large gap between trauma and nontrauma institutions. For example, among large hospitals, trauma centers provide service to more adjusted admissions and days, at higher

¹Two other analyses were conducted, but are not reported here. First, we tested the regression models with and without trauma level 1, and then trauma level 3 hospitals. Then we reran regressions, taking out only hospitals in Illinois and Missouri, the two states with abnormally high trauma unit participation. Neither analysis produced changes on the effects reported above.

cost per day, than non-trauma hospitals. Rates of pay are almost identical, however. These findings suggest that teaching status is a critical co-determinant of the utilization and cost effects of trauma designation, but bedsize is not.

- Trauma effects by year cohort are not obviously different from the effects revealed in the more general analyses. This does not mean there are no differences in sign or size of estimated coefficients; there clearly are differences. But no patterns emerge from these more focused tests that would lead to changes in our conclusions reached above.

III.4 DISCUSSION

As with any complex issue, the findings from many separate tests have not provided a neat picture of what hospitals experience when they install a trauma unit. The findings suggest that hospitals that installed such units were larger, more costly and more likely to be teaching institutions than nontrauma hospitals. It was further suggested that, when the first year experience of trauma hospitals was viewed separately, many hypothesized effects often appeared to be realized: increased total inpatient and outpatient utilization, reduced outpatient surgery, increased staffing levels. But beyond the first year, hypothesized effects "decayed," and hospitals with trauma centers regressed back toward the average for their respective classes, in almost all outcomes measured. Because these longer run post-implementation measures are the best available as tests of the impact of establishing a trauma unit, the conclusion to this analysis must be that, for the most part, trauma units have had no identifiable tendency to change overall levels of utilization costs and staffing in U.S. hospitals.

There are many reasons why no "trauma effect" emerged from these tests; additional research might sharpen the analysis, but certain problems are fundamental and will not yield to better data and more sophisticated methods.

- The trauma centers we examined may have experienced added resource requirements when implemented that have been absorbed in the general shift to greater outpatient activity. Over the past five years, physicians have treated increasing numbers of surgical and medical cases in ambulatory settings. All hospitals have experienced declining inpatient stays and, for the most part, declining inpatient admissions. Any marginal impact of a trauma unit on such a widespread structural change in the way U.S. hospitals operate would be difficult to detect. The fact that initial effects were discovered is, in fact, somewhat surprising. The fact that long run lasting effects were masked by general changes in the hospital industry seems reasonable.
- Although there is some professional agreement on what trauma centers of different levels should be, the case study research conducted for the project demonstrates that there are major operational differences between the ideal and the trauma labels that hospitals adopt. Also, not all trauma centers could be identified by level. Thus, although we included variables to identify those that provided this information, estimated differences among them could be misleading. The problem of using data from Illinois and Missouri has already been mentioned. It seems unlikely that so many hospitals in these states can function as trauma centers by the strict ACS definition. However, the more serious problems of identification come in cases not as

obviously distorted as these two states. In the absence of uniform certification standards, it is not possible to confirm the status, level, and, in some cases, the timing of implementation of many U.S. hospital-based trauma centers.

- Hospital data provide a challenge to the analyst, because, despite the AHA's best efforts, they contain both correct and incorrect "outlier" values, that tend to distort analyses based on averaging methods, such as linear regression. We made some initial attempts to trim extreme outliers, in certain important variables, so that our estimates would not be unduly influenced by extremely large (or small) or extremely costly (or inexpensive) hospitals. However, time did not permit a thorough evaluation of the distributional characteristics of these data. Had we done so, adjustments to the methodology, such as log linear transformation of the estimating equations, might have produced estimates with greater reliability. They would be unlikely to have changed our conclusions, however.

Finally, it must be recognized that the designation of trauma centers is a relatively recent development and, therefore, the time period over which hospitals with trauma centers were observed was relatively brief. For some, the "post-implementation" period was only one or two years. If the theory that the installation of a trauma unit improves overall utilization significantly is true only after several years, then our short horizon may have been a serious handicap. The limited evidence for trauma centers that implemented units in 1980 and 1981 suggests that this is not likely to be the case.

